The set up of a measuring platform for

Electromagnetical Compatibility measurements.

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Summary

Since the 1st of January 1996, European rules make that all products, which are sold on the European market, have to be equipped with a European mark, CE. To have the right to carry that mark, the product must satisfy certain demands, which are established by European standards, under which the standards of Electromagnetical compatibility (EMC).

The European Organisation for Electrotechnical Standardisation develops the General Standards. These are standards with a wide application, not related to any particular product family. They can be split in two parts: emission and immunity. The limits of emission make that the product doesn't disturb other machines in its neighbourhood. The limits of immunity make that the machine will keep working even in an electromagnetic polluted environment.

Each apparatus which is placed on the market or taken into service and which is liable to cause electromagnetic disturbance or which is itself liable to be affected by such disturbance have to be tested to look if the product meets the required limits.

These tests are done at a measuring platform. The purpose of this project is to set up such a platform. The European Standards are examined to look which test equipment is needed, which distances have to be respected etc. All this relevant information is combined in guide lines for the people who carry out the different tests.

In these guide lines is step by step in a readable manner explained what the person has to do to carry out the tests according to the standards. The tests which have to be carried out to cover the requirements of the standards, will include conducted and radiated RF emissions plus immunity to transients and electrostatic discharge.

At the end of the tests a test report must be made. In this test report should exactly be written how, where, with which equipment the tests are done.

Finally the platform is set up. The need of a Cage of Faraday was inevitable to keep the high environmental noise outside. To be sure that the equipment doesn't exceed the limits, a safety margin of 5 dB is used. The places of the equipment is indicated with signs on the floor. At the end the platform is ready to be used for electromagnetical (pre)compliance testing.

Contents

1. Introduction

Since the 1st of January 1996, European rules make that all machines which are sold on the European market, have to be equipped with a European mark, CE. If the product doesn't have that mark, it can be removed from the market and engender severe punishments. On the other hand, a product with the mark can be sold on the entire European market, without any national supplemental demands. To have the right to carry the mark CE, the product must satisfy certain demands, which are established by European standards, under which the standards of electromagnetic compatibility (EMC).

These standards can be split in two parts: emission and immunity. The limits of emission, radiating as well as conducting, make that the product doesn't disturb other machines in its neighbourhood. The limits of immunity make that the machine will keep working even in an electromagnetic polluted environment.

The purpose of this project is to set up a platform where measurements can be taken to look if the tested product meets the required limits concerning EMC. In the future, the intention is to do measurements for enterprises for the (pre)compliance tests of their products. Precompliance tests enables the manufacturer to do tests in an early stage of the development of a new product. In this way a lot of money can be saved, because if faults can be removed in an early stage of development, it prevents a lot of trouble and is much cheaper than if that is done in the final stage of development.

This project is the result of an Erasmus international exchange of students between the Eindhoven University of Technology (TUE) and the school for mechanical engineers, Institut Catholic d'Arts et Métiers (ICAM) in Nantes. For three months a Dutch student worked in a French laboratory of control engineering to set up the measuring platform mentioned above. As the intention is that that platform is used by French people, some parts of this report (like user-manuals) are written in French.

2. The standards

2.1. Introduction

Of the various aims of the creation of the Single European Market, the free movement of goods between European states is fundamental. All member states impose standards and obligations on the manufacture of goods in the interests of quality, safety, consumer protection and so forth. Because of detailed differences in procedures and requirements, these act as technical barriers to trade, fragmenting the European market and increasing costs because manufacturers have to modify their products for different national markets.

For many years the EC tried to remove these barriers by proposing Directives which gave the detailed requirements that products had to satisfy before they could be freely marketed throughout the Community, but this proved difficult because of the detailed nature of each Directive and the need for unanimity of the members before it could be adopted. To accelerate the project, the Directives are limited to setting out only the essential requirements which must be satisfied before products may be marketed anywhere within the EC. The technical detail is provided by the European standards drawn up by the European standards bodies CEN (European Organisation for Standardisation), CENELEC (European Organisation for Electrotechnical Standardisation) and ETSI (European Telecommunications Standards Institute). Also are the decisions on new approach Directives taken by qualified majority voting, eliminating the need for unanimity and so speeding up the process of adoption.

At this moment, there are about 17700 French Standards, 3300 European Standards and 13000 International Standards. National Standards can be facultatively taken from the International Standards, with or without modifications. On the other hand, each member is required to implement the European Standards, without modifications, into National Standards, with withdrawal of the divergent National Standards. This means, that products which are found to comply within one state are automatically deemed to comply within all others, no member state can refuse them entry on technical grounds. This implies subsequently, that the product, to can be sold on the entire European Market, has to pass just one test.

The mark CE, will be present on all the products which are sold on the European Market, so it can't be used by the customer to guide his choice. To distinguish the products and enterprises other, voluntary marks are available. Such as NF in France, GS in Germany and Kite-Mark in Great-Britain for products and ISO 9000 for enterprises.

In this chapter the structure of the EMC standards will be described. Further is explained when an apparatus must be tested and when the CE mark can be affixed to the product.

2.2. The EMC-standards

One group of standards are the EMC-standards. The ever greater use of electronic equipment around the world has led to an increasing awareness of the importance of electromagnetic compatibility. This is defined as the ability of a device, unit of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. So the term EMC has two complementary aspects:

- it describes the ability of electrical and electronic systems to operate without interfering with other systems → the emission
- it also describes the ability of such systems to operate as intended within a specified electromagnetic environment → the immunity

Because of the importance of EMC, great effort has been expended over recent years in designing methods of measurement of EMC performance, in laying down acceptable (and achievable) standards of performance and in drafting legal requirements to impose compliance with these standards on manufacturers of electronic equipment.

The structure of the EMC-standards is as follows:

1. Basic Standards
2. General Standards
3. Standards of product families
4. Standards dedicated to specific products

There are many industry sectors for which no product-specific standards have been developed. In order to fill this gap wherever possible, CENELEC have given a high priority to developing the General Standards. These are standards with a wide application, not related to any particular product or product family, and are intended to represent the essential requirements of the Directive. They are divided into two standards, one for immunity and one for emissions, each of which has separate parts for different environment classes. Where a relevant product-specific standard does exist, this takes precedence over the generic standard.

The interesting standards for this project are given in Table 1.

In these standards is also indicated which test equipment is required to carry out the test. To do the tests in accordance with the standards, the following test equipment, mentioned in these standards, is bought*:

- Burst Tester, to couple nanosecond spikes into the mains EUT (Equipment Under Test) supply or into data and communication lines with the
- HF-Coupling clamp
- Electro Discharge Tester, produces electrostatic discharges to evaluate the performance of the electrical equipment under test

- Spectrum Analyser,
- Computer Interface, to connect a computer to the spectrum analyser so the spectrum can be seen on the computer screen
- E and H near-field probes, to locate emission sources
- Log-Periodic Antenna, to measure radiation over the frequency range 30 Mhz to 1 GHz.
- Pre-amplifier, to amplify the low level signals of the antennas and near field probes,
- Line Impedance Stabilisation Network (LISN), machine to imitate the required fictive network and to provide the transducer for measurement of RF conducted back down the mains from the EUT.
- Isolation Transformer, required for the LISN, because of its leakage currents it can't be connected directly to the mains supplies of the laboratory, for the earth leakage circuit breaker will be immediately activated
- Cage of Faraday, needed to keep the environmental parasites outside

Emission		Immunity	
EN 50081-1	Generic emission standard Part 1: Residential, commercial and light industry	EN 61000-4-1	Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 1: Overview of immunity tests - Basic EMC publication
EN 50081-2	Part 2: Industrial environment	EN 61000-4-2	Section 2: Electrostatic discharge immunity test
EN 50082-1	Generic immunity standard Part 1: Residential, commercial and light industry	EN 61000-4-4	Section 4: Electrical fast transient / burst immunity test
EN 50082-2	Part 2: Industrial environment		
EN 55011	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment		
EN 55022	Limits and methods of measurement of radio disturbance characteristics of information technology equipment		

Table 1

Not all information given in the standards mentioned above is interesting. Only the interesting information and the information given in the manuals of the test-equipment are joint together in the guide lines for the person who carries out the test. These guide lines are written in French as the person who carries out the tests will be French. The guide lines can be found in annex A and are explained in the next chapter.

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* For further details of the equipment, see annex B

2.3. Which products must be tested ?

The EMC Directive applies to an apparatus which is placed on the market or taken into service and which is liable to cause electromagnetic disturbance or which is itself liable to be affected by such disturbance. «Apparatus» is defined as all electrical and electronic appliances, equipment and installations.

«Placing on the market» means the first making available of the product within the EC, so that the Directive covers only new products manufactured within the EC, but both new and used products imported from a third country. If the product is manufactured in or imported into the EC for subsequent export to a third country, it has not been placed on the market.

«Taken into service» means the first use of a product in the EC by its final user. If the product is used without being placed on the market, if for example the manufacturer is also the end user, then the protection requirements of the Directive still apply. On the other hand, it should not need to go through the conformity assessment procedures to demonstrate compliance. So the test-site which will be set up, can also be used to look if the equipment ICAM makes for itself doesn't exceed the given limits.

If the manufacturer resides outside the EC, then the responsibility for certifying compliance with the Directive rests with the person placing the product on the market for the first time within the EC, i.e. the manufacturer's authorised representative or the importer. Any person who produces a new finished product from already existing finished products, such as a system builder, is considered to be the manufacturer of the new finished product.

The question of when does a component (which is not within the scope of the Directive) become apparatus (which is) remains problematical. The Commission's interpretative document defines a component to be «any item which is used in the composition of an apparatus and which is not itself an apparatus with an intrinsic function intended for the final consumer». Thus individual parts such as ICs and resistors are definitely outside the Directive.

2.4. Testing and test-houses

Except in the case of products which clearly will intrinsically not cause interference or be susceptible to it, such as a pocket torch, each manufacturer will need to submit products to some degree of EMC testing to be sure that they comply with the Directive. To cover the eventual requirements of the standards, the scope of the tests will need to include conducted and radiated RF emissions plus immunity to transients and electrostatic discharge. A test facility to address all these phenomena at compliance level is beyond the budget of most small to medium sized companies. A large company may have the product volume and available capital which justifies investment in an in-house facility. Small to medium sized enterprises which are not able to afford their own full-scale test facilities, will often make use of independent test houses, as ICAM will become one.

2.5. The CE mark and the declaration of conformity

The manufacturer or his authorised representative is required to attest that the protection requirements of the Directive have been met. This requires two things:

- he issues a declaration of conformity which must be kept available to the enforcement authority for ten years following the placing of the apparatus on the market
- he affixes the CE mark to the apparatus, or to its packaging, instructions or guarantee certificate

The EC declaration of conformity must include the following components:

- a description of the apparatus to which it refers
- a reference to the specifications under which conformity is declared, and where appropriate to the national measures implemented to ensure conformity
- an identification of the signatory empowered to bind the manufacturer or his authorised representative

The mark consists of the letters CE as shown in figure 1. The mark should be at least 5 mm in height and be affixed visibly, legibly and indelibly.

Figure 1: *The CE-mark*

3. The Guide lines

3.1. Introduction

For the standards contain much more information that is interesting for this project, guide lines are formulated (see annex A). These guide lines contain only the relevant information of the standards. This prevents the person who carries out the test to read the standards, which are not always as easy to read.

It is tried to translate the information of the norms in a readable manner. Therefore is step by step in a flow chart explained what the person has to do to carry out these tests according to the standards.

In this chapter these guide lines are further explained where necessary.

3.2. Radiated emission testing

For ease of measurement and analysis, radiated emissions are assumed to predominate above 30 Mhz and conducted emissions are assumed to predominate below 30 Mhz. There is of course no magic changeover at 30 Mhz, but typical cable lengths tend to resonate above 30 Mhz, leading to anomalous conducted measurements, while measurements of radiated fields below 30 Mhz will necessary be made in the near field, which gives results that do not necessarily correlate with real situations.

The first guide line has to check the radiated emission of the EUT. The first page is to look which standard is applicable and to which class and group the apparatus belongs, this is important to chose the right limits. On the next page, is told how to place the EUT and the necessary test equipment, as described in the standards. The EUT has to be positioned so that its boundary is at a specific distance from the measuring antenna, normally this distance is 3 meters. A non-floor-standing EUT should be 0.8 m above the ground plane. The EUT needs also to be rotated 360° to find the maximum emission.

After that, the settings of the analyser and computer are given. There are two kinds of detector in common use in emissions measurements: quasi peak and average. The quasi-peak detector is a peak detector with weighted charge and discharge times which correct for the subjective human response to pulse-type interference. Interference at low pulse repetition frequencies (PRF) is subjectively less annoying on radio reception than that at high PRFs. Therefore, the quasi-peak response de-emphasises the peak response at low PRFs. The average detector, as its name implies, measures the average value of the signal. For a continuous signal this will be the same as its peak value, but a pulsed or modulated signal will have an average level lower than the peak. The

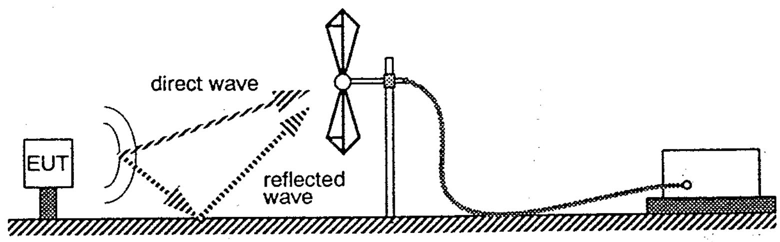


Figure 2: *Reflected and direct waves captured by the antenna*

effect of this is to penalise continuous emissions with respect to pulsed interference, which registers a lower level on an average detector.

Then the height of the antenna has to be adjusted, such that the received signal is as strong as possible. That is needed, because the antenna not only measures the direct signal from the EUT, but also any signals that are reflected from conducting objects such as the walls, the ground plane and the ceiling. They are not equipped with anti-reflection cones, to prevent the investment being too large. On the other hand, 3 movable panels are equipped with absorbing cones. These panels are placed just next to the EUT (see figure 8), to prevent reflections as much as possible. The remained reflections cause points where the waves extinguish each other as well as points where the waves are amplied. By varying the height of the antenna, the relative distances of the direct and reflected paths change, see figure 2. To do reproducible measurements the antenna has to be placed in one of the points where the waves are amplified as much as possible.

Now the environmental noise is measured. As the tests are done in a cage of Faraday, there will be no problems with the strength of the environmental noise. So this is just done to verify if the cage shows no leakage. Then the emission of the EUT is measured and checked to stay within the given limits. It is wise to respect a safety margin of 5 dB under the given limits, because it is practically impossible to do reproducible measurements and also because the cage is not completely equipped with anti-reflection cones. If it doesn't exceed the limits minus 5 dB, the EUT respects the norms EMC as far as the radiated emission is concerned.

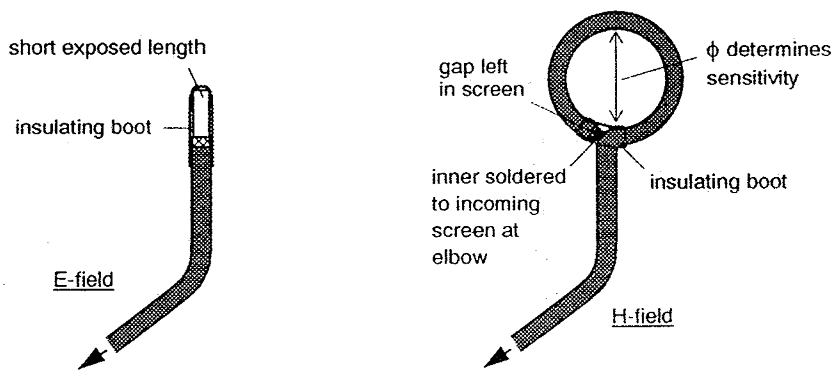


Figure 3: *Near field probes*

If the given limits minus 5 dB are exceeded, the sources of the concerned frequencies are tried to be found, with the near field probes. These detect field strength in the near field. Therefore two types of probe are needed, one for the electric field (rod construction) and the other for the magnetic field (loop construction) (see figure 3). The electrical field probe will detect nodes of high dv/dt, while the magnetic field probe will detect paths of high di/dt. As soon as the components, which produces the concerned frequencies are found, it is tried to give a solution to the problem. In this way the manufacturer of the EUT can change the design of his product, so it can meet the given limits.

3.3. Conducted emission testing

The second guide line talks about conducted emission on the mains port. As said before, this concerns only emitted frequencies below 30 Mhz.

To make these tests, an artificial mains network or Line Impedance Stabilising Network (LISN) is needed to provide a defined impedance at RF across the measuring point, to couple the measuring point to the test instrumentation and to isolate the test circuit from unwanted interference signals on the supply mains. When the LISN is exposed to the 240 V line voltage there will be a current of about 0.75 A in the safety earth. This level of current is lethal, and the unit must therefore be solidly connected to earth for safety reasons. If it is not, the LISN case, the measurement signal lead and the EUT can all become live. A secondary consequence of this high earth current is that LISNs cannot be used on mains circuits that are protected by earth leakage or residual current circuit breakers. It is therefore that an isolation transformer is used between the local power supply network and the LISN.

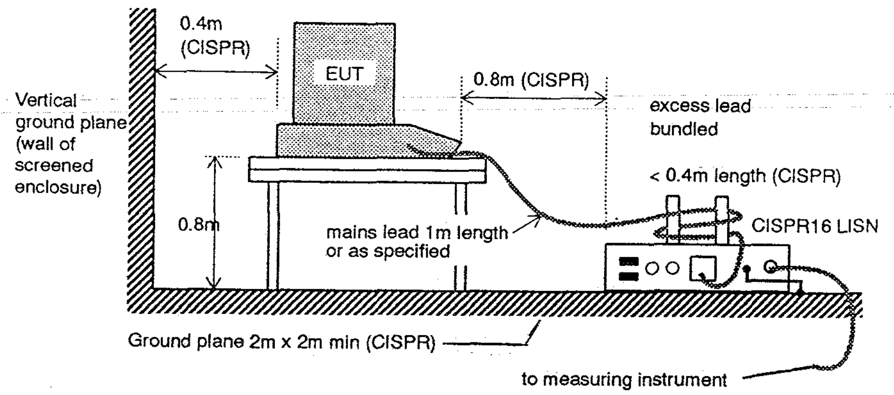


Figure 4: *Layout for conducted emission tests*

The principal requirement is placement of the EUT with respect to the ground plane and the LISN, and the disposition of the mains cable and earth connection(s). This is given in the guide lines and also show in figure 4.

There are measurements taken as well on the live as on the neutral wire. Here will also be tried to give suggestions to ameliorate the tested product if it exceeds the given limits.

3.4. ESD immunity testing

The third guide line will test the electrostatic discharge immunity of the EUT. For the tests, the EUT should be set up in its operating configuration. The connection to the ground is important, and this should be representative of installation or user practice. Table-top equipment should be placed on a wooden table 80 cm over the ground plane, with a horizontal coupling plane directly underneath it but insulated from it. The coupling plane must be connected with the ground, using a cable equipped with a 470 kΩ resistance at each end. Floor standing equipment should be isolated from the ground plane by an insulating support of about 10 cm.

After the equipment is installed, the points to which the electrostatic discharges are executed are chosen. These points have to be points which are accessible to the operator during normal utilisation or maintenance. Also the level of the electrostatic discharge has to be chosen, this depends on the relative humidity of the air and the material of which the equipment consists. Finally there has to be decided if contact discharges or discharges in the air are applied. Contact discharge is preferred, but this requires that the EUT has conducting surfaces or painted surfaces which are not regarded as insulating. For a product where this is not possible (e.g. with an overall plastic enclosure) air discharges are used.

During the tests, the tension is increased until the apparatus stops working or until the chosen level is reached. If the apparatus stops working before the chosen level is reached and the malfunction is not temporary or recoverable, the EUT doesn't respect the standards. If the malfunction is temporary or recoverable, the EUT does respect the standards as far as direct electrostatic discharges are concerned. Then the apparatus can be classified as a class 2 or class 3 apparatus, which depends on the system needing an intervention of an operator (class 3) or not (class 2) to restart it. And if the chosen level is reached and the apparatus still works properly, the EUT respects the standards and will be a class 1 apparatus.

After that also indirect electrostatic discharges are applied. These are executed using vertical coupling planes, placed at a distance of 10 cm to the EUT, which simulate equipment which is situated next to the EUT. The same criteria as above are used to decide whether or not an apparatus respects the norms. At the end the level of test and the class to which the apparatus belongs are written in the user manual of the apparatus.

3.5. Transient burst immunity

The fourth and last guide line will test the immunity of the EUT to bursts on the main supply. Also here table top EUTs are placed on an insulating table 80 cm above the ground, and floor standing equipment is stood off from the ground plane by a 10 cm insulating block. I/O cables are fed through the capacitive clamp which is located 10 cm above the ground plane and connected to the burst generator.

Typically, bursts are applied for a duration of 1 minute in each polarity. The required voltage levels are defined in the relevant standard, and vary depending on the anticipated operating environment. The burst consists of many spikes (see figure 5). The burst frequency is 3 Hz and the length of the burst is about 15 ms. The spike frequency depends on the chosen voltage level. When surges are applied to the mains input, they are qynchronised with the mains waveform so as to occur at the worst case point on it (normally the positive and negative peaks).

Here also the apparatus is categorised in the same classes as with the electrostatic discharge:

- Class 1: the apparatus keeps working properly

- Class 2: temporary malfunction or self-recovering
- Class 3: malfunction which need the intervention of an operator.

At the end the level of test and the class to which the apparatus belongs are written in the user manual of the apparatus.

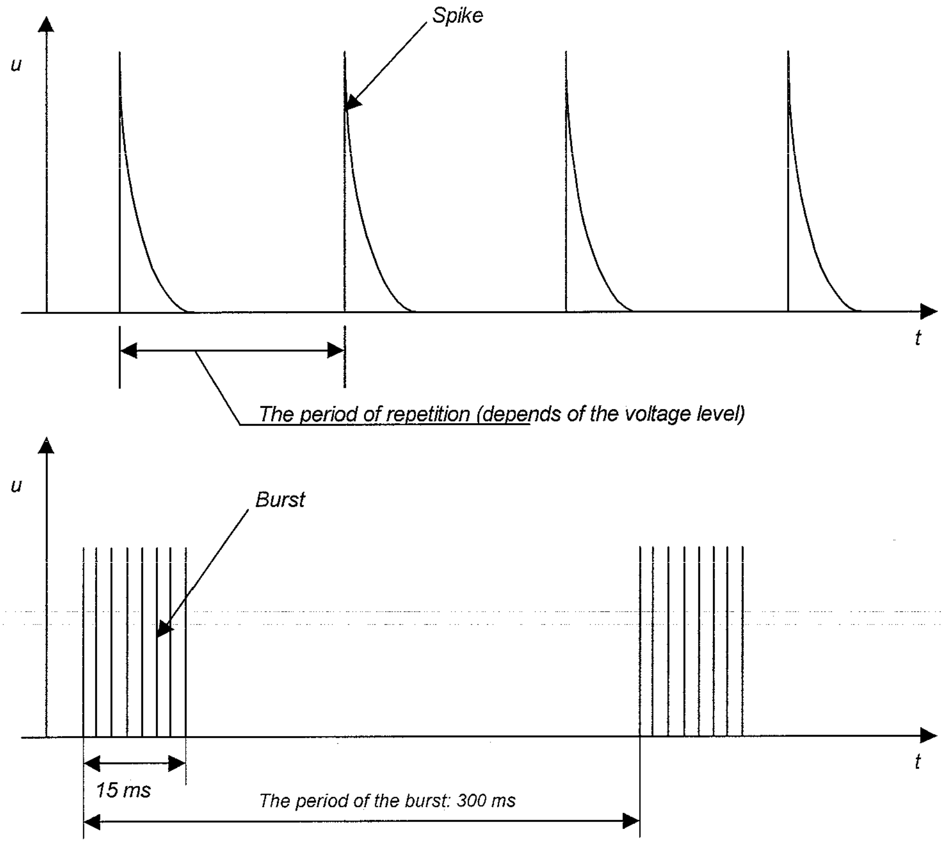


Figure 5: *Properties of bursts and spikes*

4. Test report

4.1. Introduction

When all tests are done, the results have to be presented in a test report. In this report must exactly be described how, where and with what the tests are executed, so that other people eventually can reproduce the measurements. Finally conclusions are drawn from the measuring results: the apparatus does or doesn't respect the European standards. If it doesn't, it is tried to give suggestions to adapt the design of the product.

The contents of the test report are described in the next section.

4.2. Contents

1. *Introduction*

   Here is told why it is so important to test the electromagnetical compatibility of an apparatus. Also is told that doing precompliance tests can save money an a lot of trouble.

2. *Information of the company for which the tests are done*

   Here is given the name, address and phone and fax number of the company for which the tests are done. Also is the name (and phone number) of the contact person given.

3. *Description of the EUT*

   The basic description of the EUT must specify the model number.

   - Is the EUT stand-alone or part of a larger system ?

     If it is to be tested as a stand-alone unit then no further information is needed. If it can only be tested as part of a system then the components of the system of which it is a part must also be specified. Care must be taken that the test results will not be compromised by a failure on the part of other system components.

   - System configuration and criteria for choosing it

     If the EUT can form part of a system or installation which may contain many other different components, you will need to specify a representative system configuration which will allow you to perform the tests. The criteria on which the choice of configuration is based must be clear.

4. *The tests to be performed*

   - Which standard is used ?

     In the standard, the applied voltage levels and frequency ranges are specified.

   - Test equipment and facility to be used

   - Location of test points

     The number of lines to be tested. In some cases just one representative line can be tested and claimed that it covers all others of the same type. The position of the test point can be critical, especially for electrostatic discharge application, and must be specified. The choice of ESD application points should be supported by an assessment of likely use of the equipment and/or some preliminary testing to determine weak points.

   - EUT operating modes

     If there are several different operating modes, then it may be possible to identify a worst case mode.

- Test schedule, including sequence of tests

  The order in which tests are applied may or may not be critical, but should be specified.

5. *Requirements of the test facility*

- Environmental conditions

  Special requirements for temperature, humidity, vibration etc.

- Safety precautions needed

  If the EUT uses ionising radiations or extra high voltages, is dangerously heavy or hot, or if the tests require high values of radiated field

6. *Sketch and details of test set-up*

- Physical location and layout of EUT and test instrumentation

  Critical points are distances, orientation and proximity to other objects, especially the ground plane. The final test report should include photographs which record the set-up.

- Electrical interconnections

  Cable layout and routing has a critical effect at high frequencies and must be closely defined. Also the types of connector and cable to the EUT should be specified, if they would otherwise go by default.

7. *Test results*

8. *Conclusions*

   Interpretation of the test results. Does the apparatus meet the given standards, or doesn't it ? If it doesn't, suggestions to change the apparatus must be given. Also must be noted if a warning message must be noted in the manual.

5. Placing of the measuring platform

5.1. Introduction

In the end, the purpose of this project is to set up a measuring platform where equipment can be tested, concerning the European EMC standards. In this chapter, the choices which are made to set up such a platform are explained.

5.2. Setting up

First, the electromagnetical environmental noise is measured (see figure 6). This figure proves that the environmental noise is much larger than the limits the equipment has to comply with. So it is impossible to distinguish the difference between the emission of the equipment, and the environmental noise. Therefore, it is decided to place a cage of Faraday. From figure 7, the result of a measurement of the environmental noise in the cage, can be seen that disturbing external sources are hardly noticeable. The cage is also equipped with three panels with HF-absorbing cones to decrease reflections and so to approach an open site. The dimensions of the cage are 7.5 x 3.4 x 2.5. The dimensions of the room in which it will be placed are taken into account.

Secondly, the measuring equipment has to be positioned and placed. For this, the distances, as they are mentioned in the standards, must be taken into account. Signs will be put on the ground to indicate the place of the different equipment.

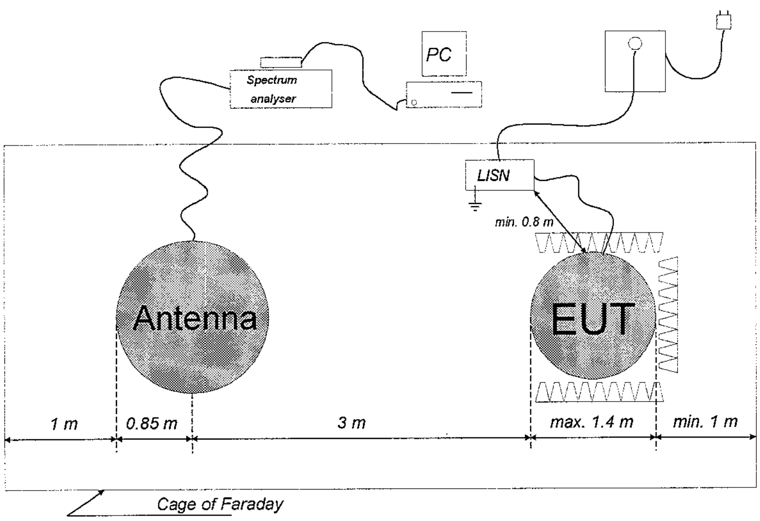


Figure 8: *Layout for radiated emission testing*

For radiated emission testing, the distance between the outline of the antenna and the wall of the cage has to be at least 0.5 meter. The distance from the middle of the antenna to the outline of the EUT has to be at least 3 meters. The distance between the outline of the EUT and the walls of the cage has to be at least 1 meter. Finally, the distance between the LISN and the outline of the EUT has to be at least 0.8 meter. The antenna and the EUT are being placed in the manner as shown in figure 8,

respecting all distances mentioned above. All other necessary equipment is being placed as much as possible outside the cage, as also shown in figure 8.

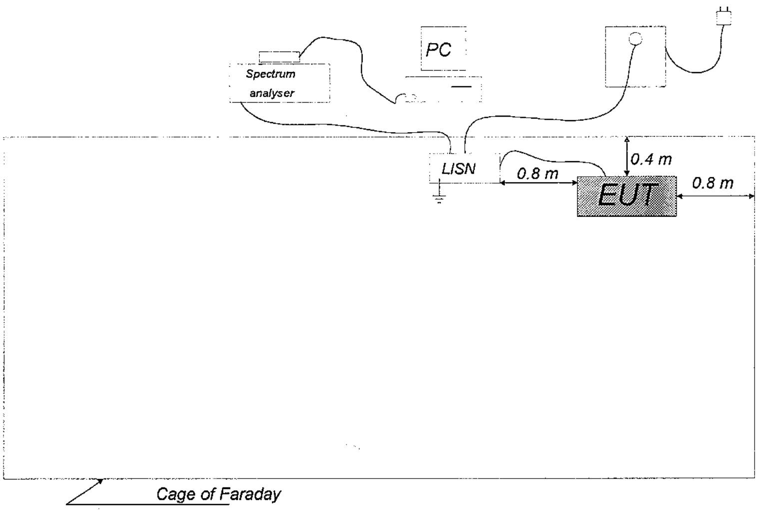


Figure 9: *Layout for conducted emission testing*

For the conducted emission testing the distance between one wall and the EUT must be 0.4 meter. The distance between all other walls and the EUT must be at least 0.8 meter. Here also the distance between the LISN and the EUT has to be 0.8 meter. All other necessary equipment are placed outside the cage. So the equipment to do the conducted emission testing is placed as shown in figure 9.

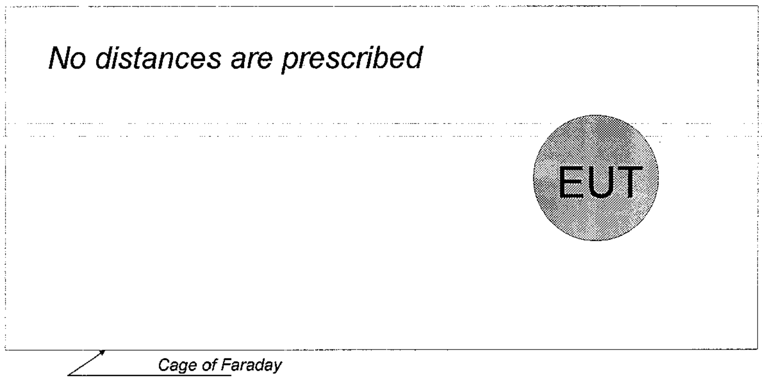


Figure 10: *Layout for both ESD and transient burst immunity testing*

For the electrostatic discharge immunity testing no distances are given, which have to be respected. It is decided to carry out these test at the same place in the cage of Faraday as with the radiated emission tests (See figure 10).

By the transient burst immunity testing, the distance between the EUT and all other conducting surfaces must be at least 0.5 meter. This distance is respected if the EUT is placed at the same place as with the radiated emission tests. So also the layout for the transient burst immunity testing is given in figure 10. The wires between the EUT and the test equipment must be at most 1 meter.

6. Conclusion

The intention was to set up a measuring platform to do EMC measurements. After three months the measuring platform was almost ready. Some test measurements are done for the emission testing and the electrostatic discharge immunity testing. Only the transient burst testing has not yet been set up. It is decided to do that somewhat later, when the people working with the platform already have some experience with the emission and ESD testing. With the made guide lines the rules, with which the measurements should be done, are clear and nothing will be forgotten.

Because the cage is not totally equiped with absorbing cones, two interesting tests can be made to verify if the margin of 5 dB under the given limits of the rayonning emission test is sufficient. The first test is to compare the measured emission of a EUT in this cage with the measured emission of the same EUT in a cage which is totally equiped with absorbing cones. ICAM has that possibility, because DICOMTECH has a cage of Faraday which is said to simulate well an open field area. They already proposed to do some verification measurements. If the difference between the two measurements is greater than 5 dB, the margin must be adapted. Another possibility is to buy a “EUT” of which exactly is known which level of disturbance should be measured at a distance of 3 meters of the apparatus in an open field area. If the real measured level of disturbances differs more than 5 dB, the margin must be adapted.

Further in the future, if the experience of the people working with the measuring equipment is great enough, it is possible to expand the possibilities of the platform, by buying equipment to do also rayonning immunity tests. To do these test it is really necessary that the cage of Faraday is totally equiped with absorbing cones, because the emitted waves are much stronger than the emitted waves of a EUT, and thus causing more and stronger reflections.

It is clear that ICAM will have a lot of benefit of this measuring platform. Not only for their own products, but certainly also to test products of other companies. During the set up of the platform some companies were already interested in the possibilities of such a measuring platform in the neighbourhood. As far as I’m concerned this platform will be as well technically as economically a big succes for ICAM.

Annex A: The guide lines

Directives
pour faire des essais de
CEM

École d'ingénieurs

TOULOUSE
NANTES
LILLE

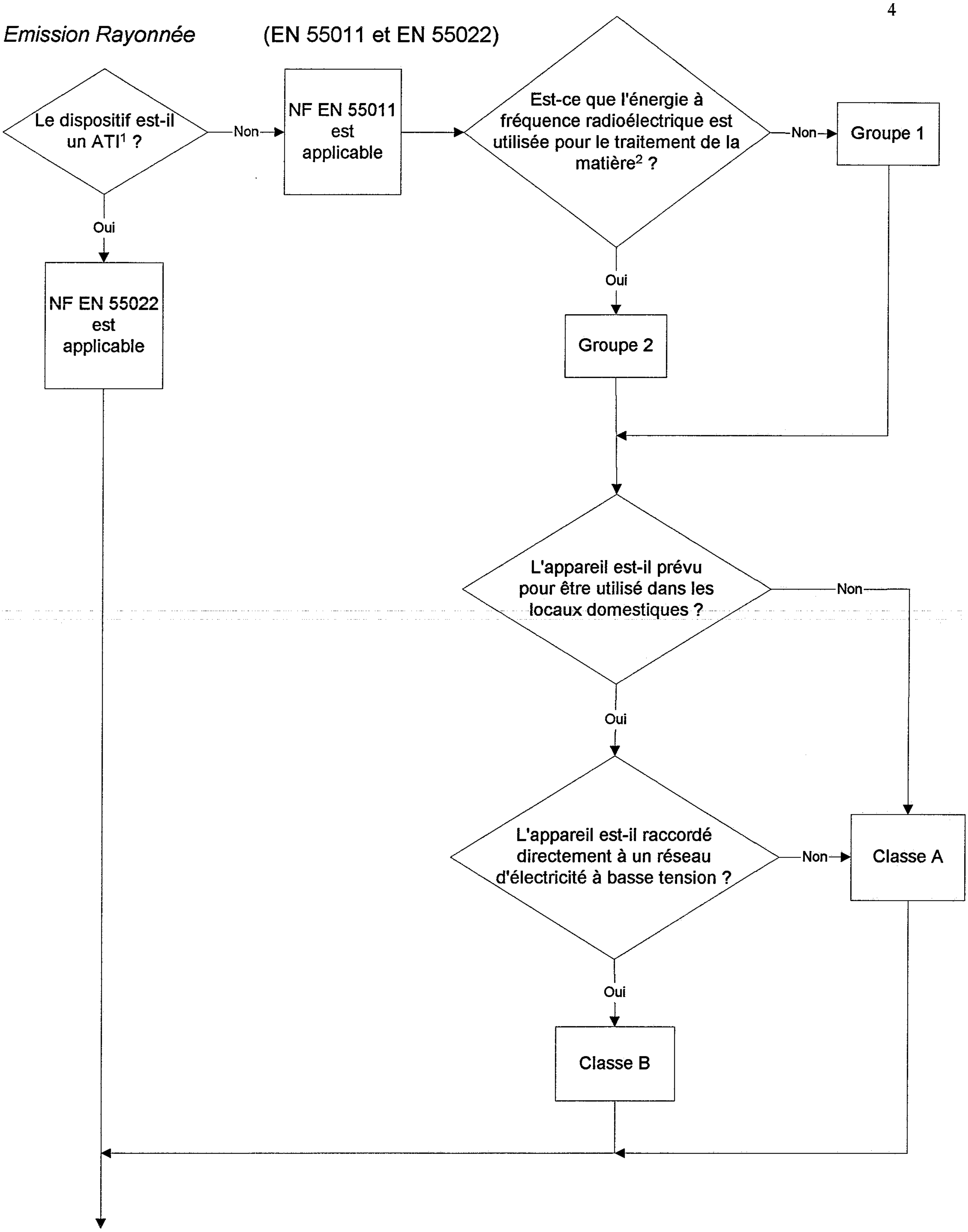
ICAM - Nantes
Laboratoire Automatique
Carquefou, juillet 1996
Auteur: Gwen VAN VUGT
Accompagnateur: Joseph WEEXSTEEN

Table des matières

1. Directives

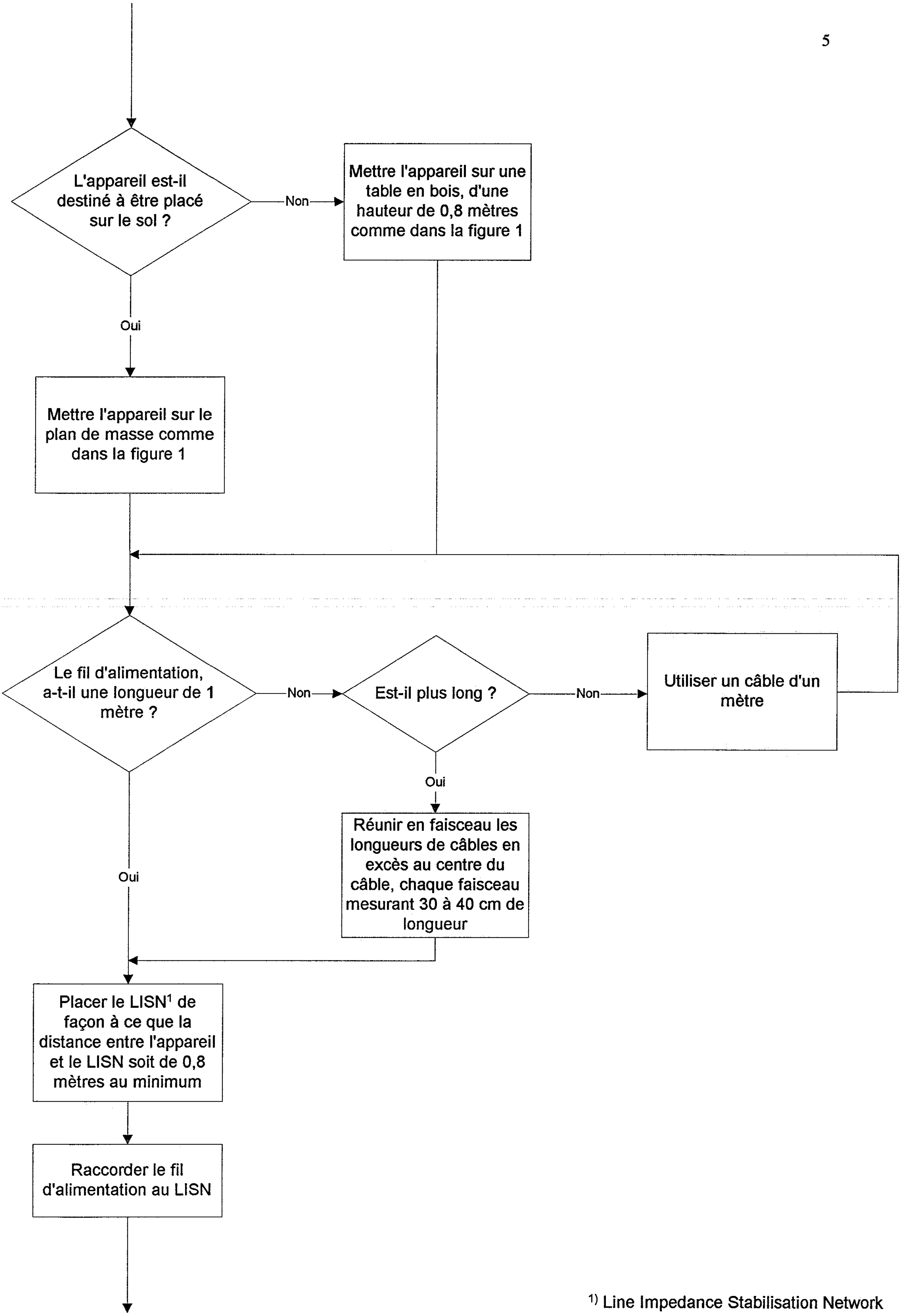
Dispositif à soumettre à un test

Emission Rayonnée (EN 55011 et EN 55022)

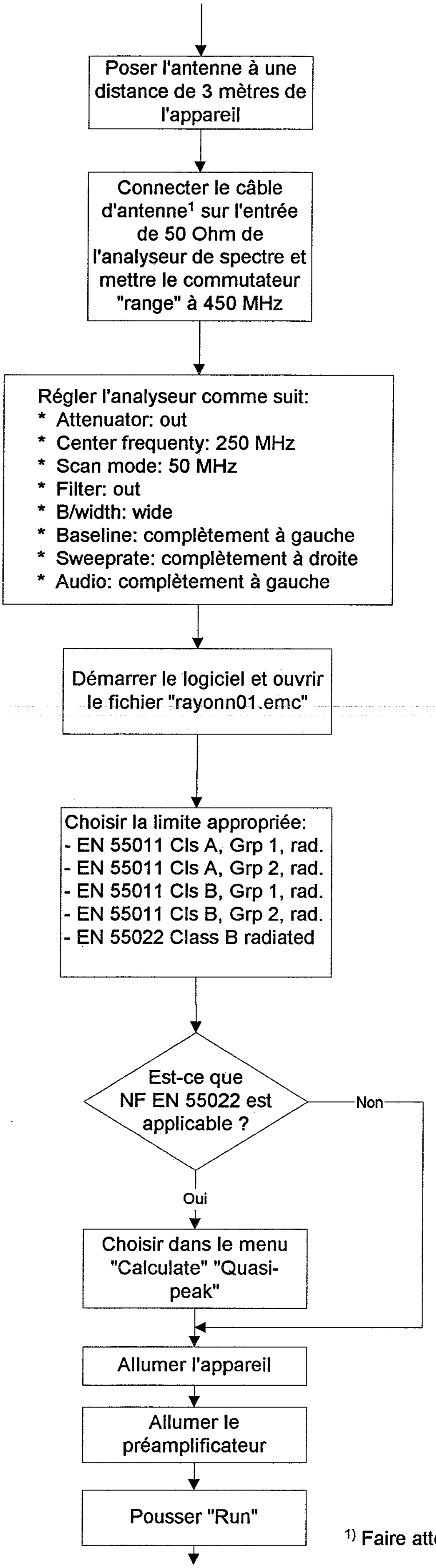


1) Appareil de Traitement de l'Information

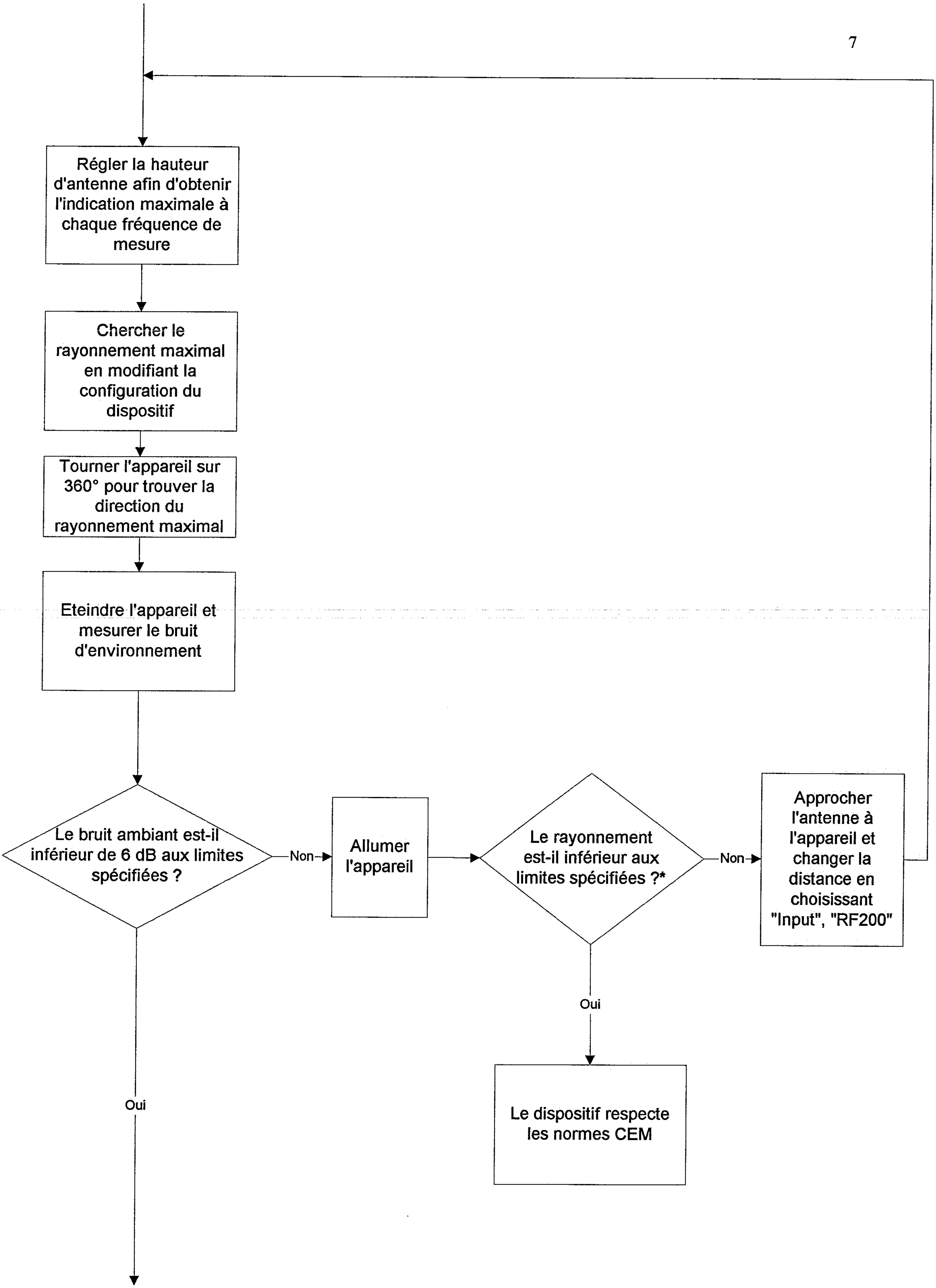
2) Par exemple un appareil à électro-érosion

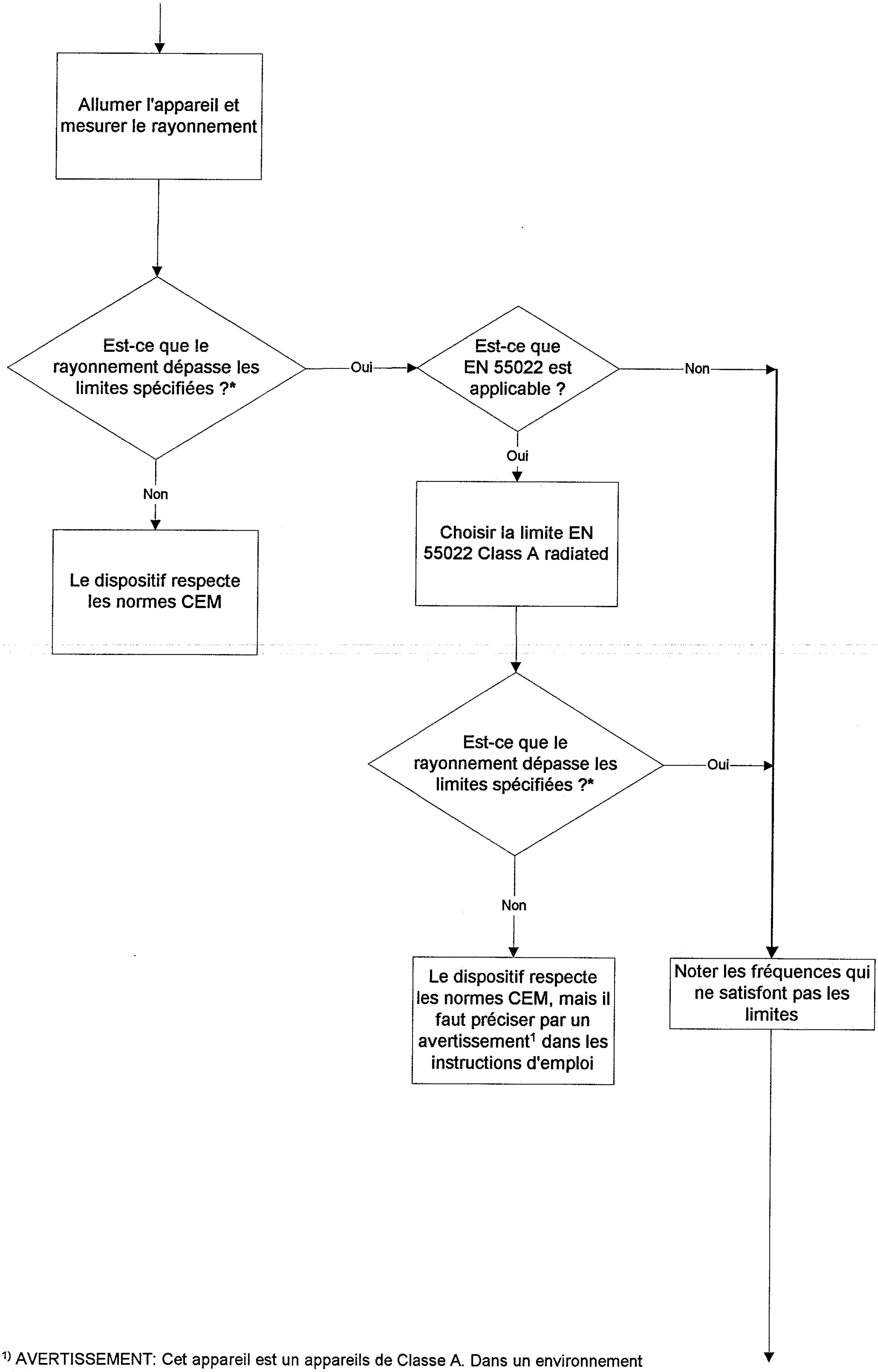


1) Line Impedance Stabilisation Network

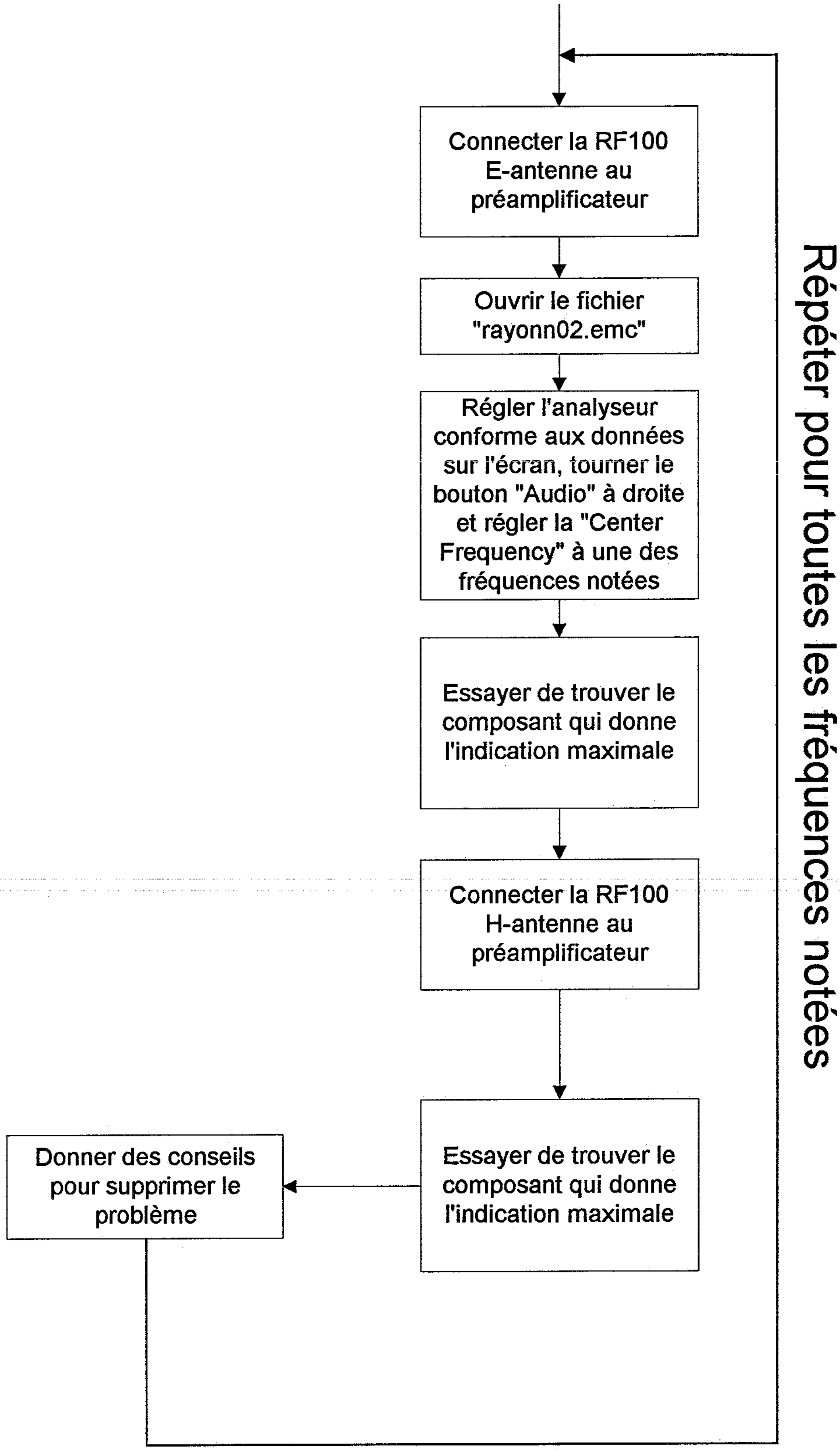


[1]) Faire attention que le cable d'antenne ait une longueur totale de 5 mètres


Régler la hauteur d'antenne afin d'obtenir l'indication maximale à chaque fréquence de mesure
Chercher le rayonnement maximal en modifiant la configuration du dispositif
Tourner l'appareil sur 360° pour trouver la direction du rayonnement maximal
Eteindre l'appareil et mesurer le bruit d'environnement
Le bruit ambiant est-il inférieur de 6 dB aux limites spécifiées ?
Non
Allumer l'appareil
Le rayonnement est-il inférieur aux limites spécifiées ?*
Non
Approcher l'antenne à l'appareil et changer la distance en choisissant "Input", "RF200"
Oui
Le dispositif respecte les normes CEM
Oui



[1]) AVERTISSEMENT: Cet appareil est un appareils de Classe A. Dans un environnement résidentiel cet appareil peut provoquer des brouillages radioélectriques. Dans ce cas, il peut être demandé à l'utilisateur de prendre des mesures appropriées.

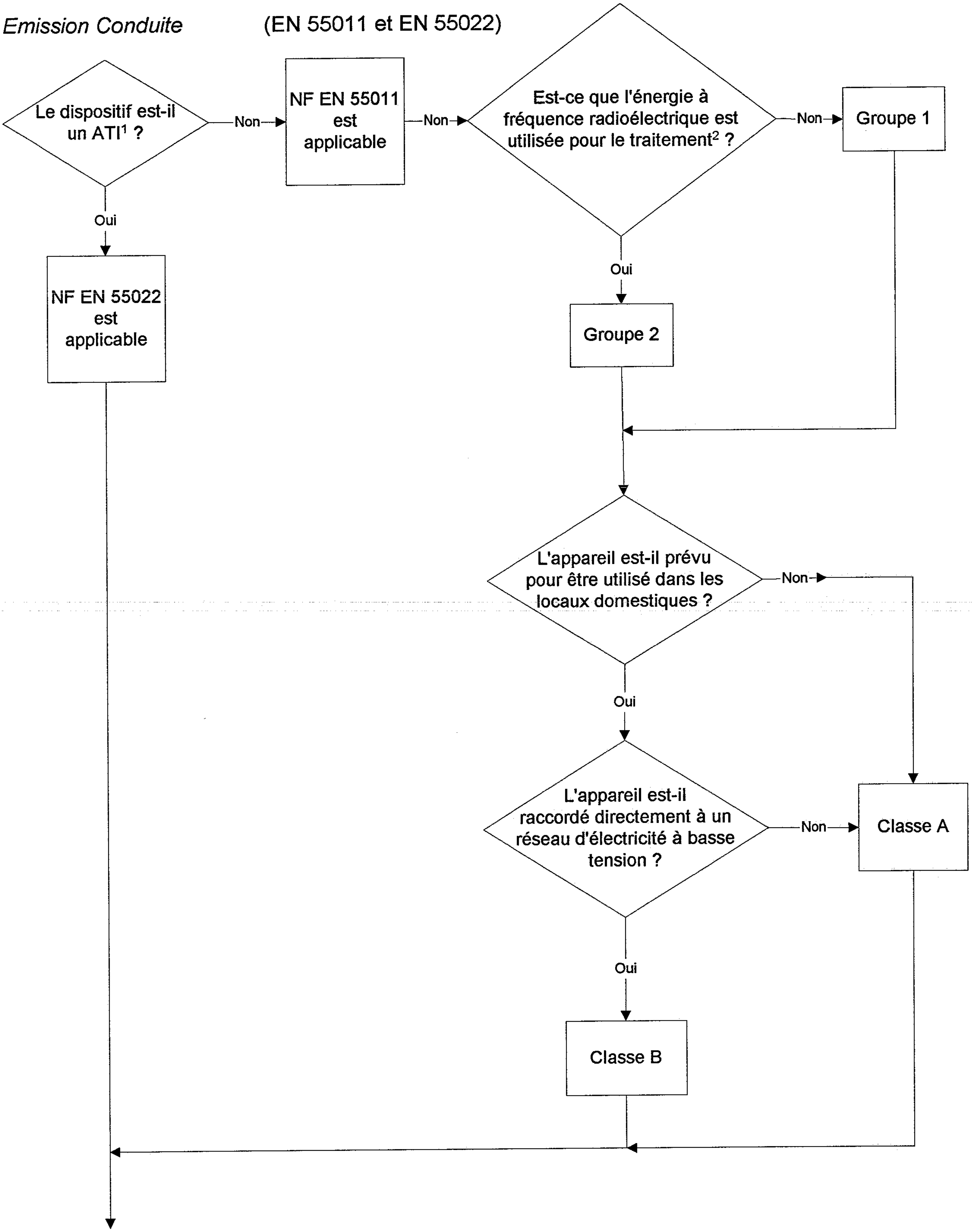


*) Si l'indication montre des fluctuations à proximité de la limite, cette indication doit être observée pendant 15 s: L'indication la plus élevée doit être notée

Pour raisons de sécurité il est raisonable de respecter un marge de 5dB au dessous des limites.

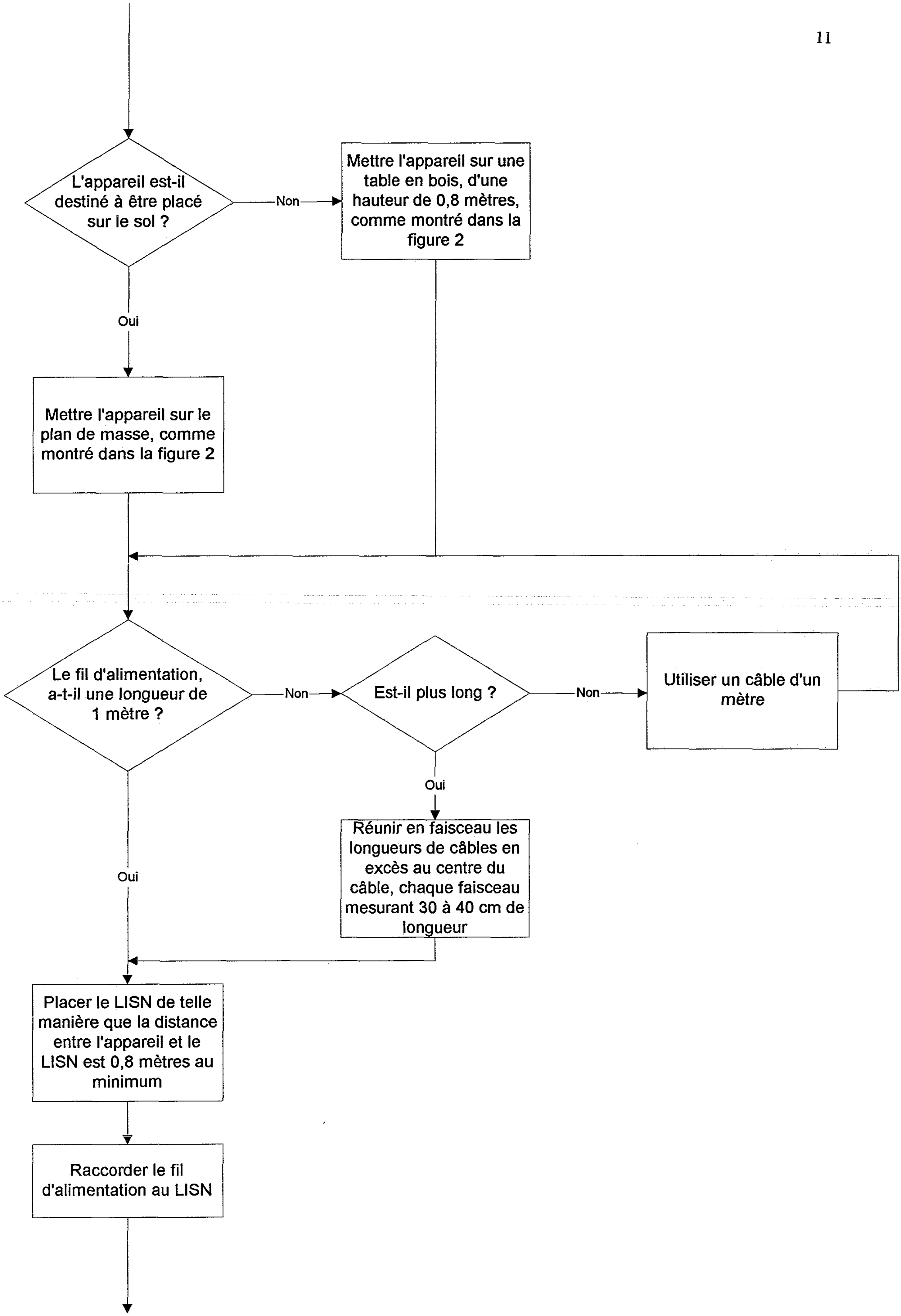
Dispositif à soumettre à un test

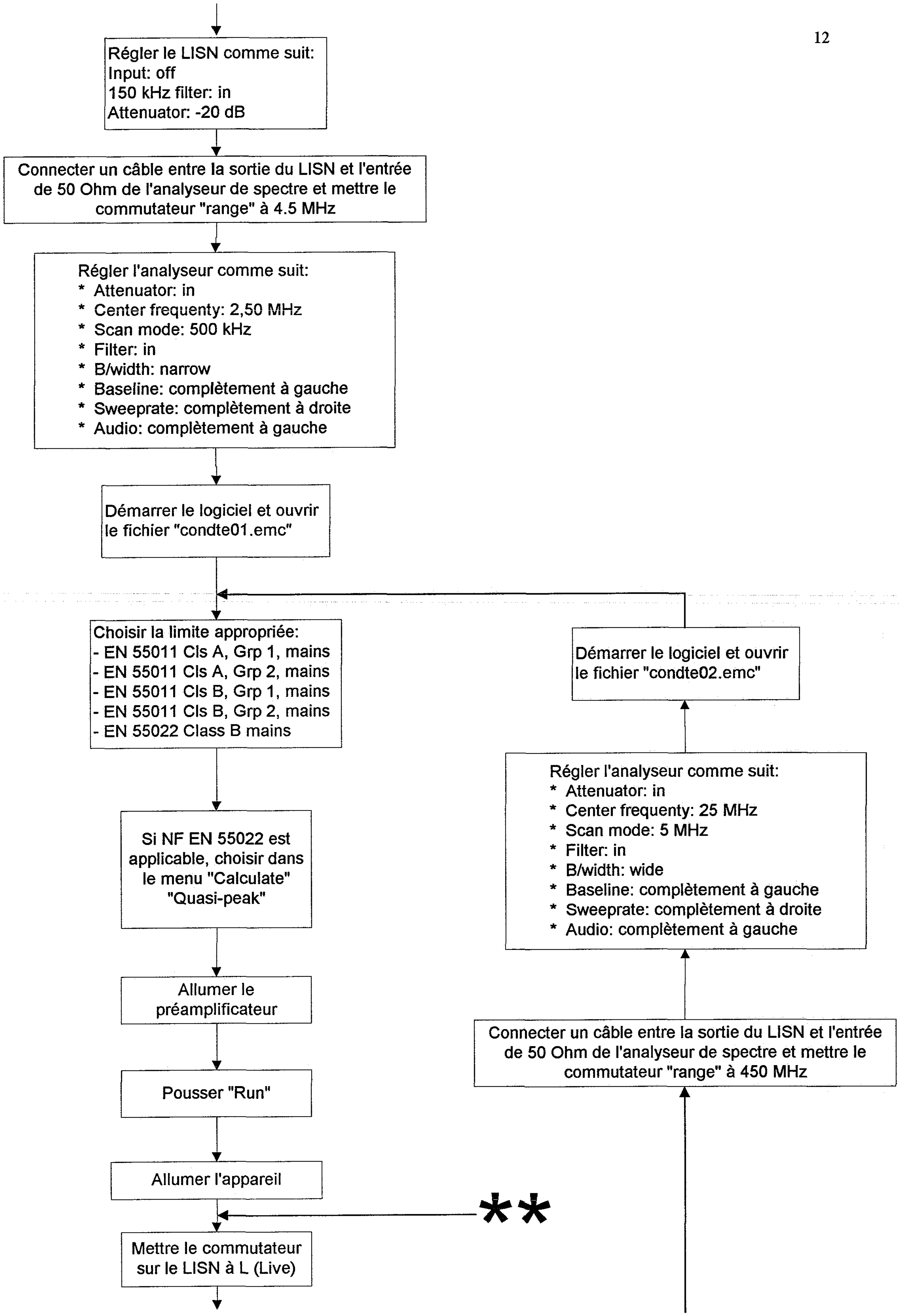
Emission Conduite (EN 55011 et EN 55022)



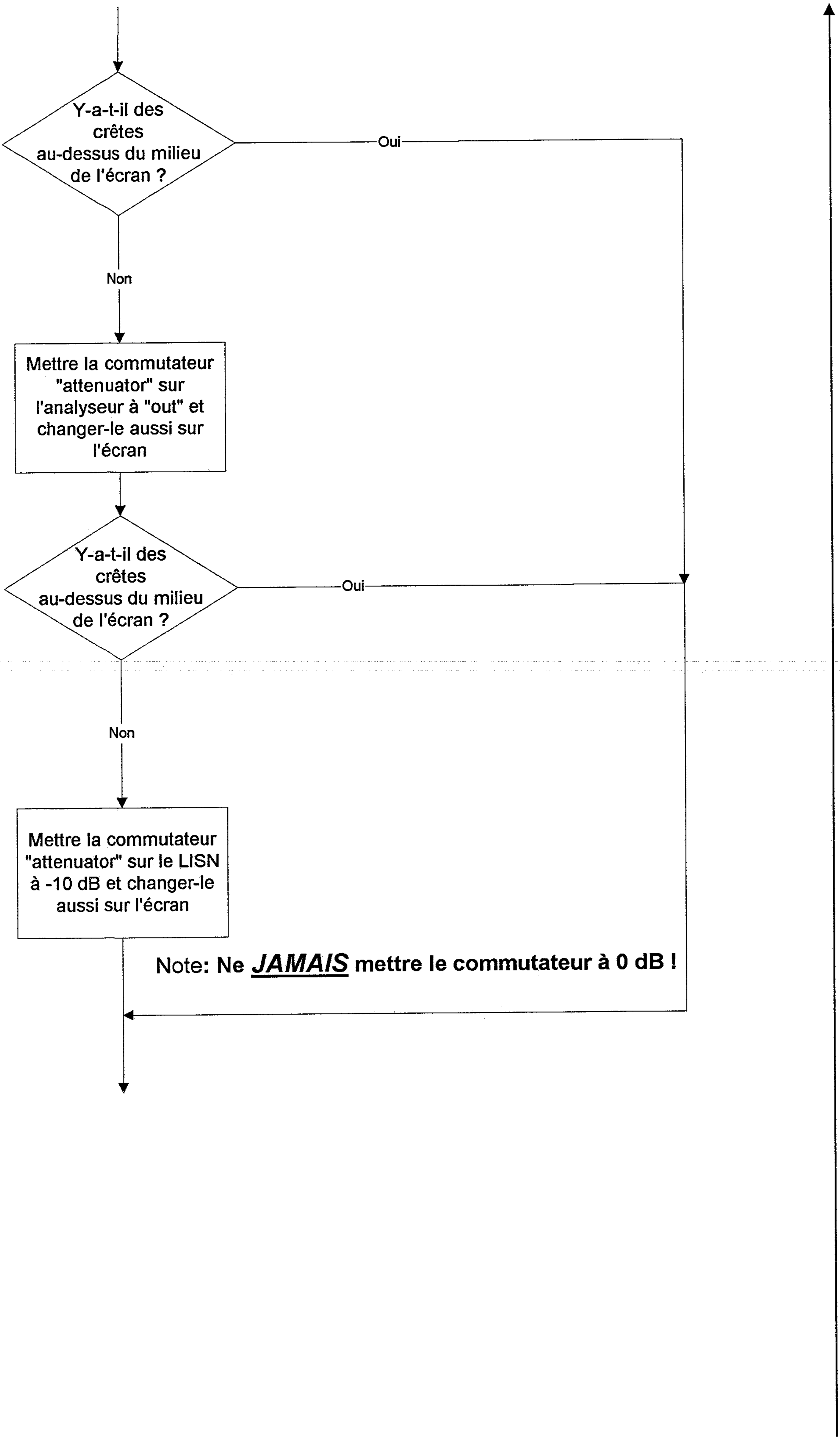
1) Appareil de Traitement de l'Information

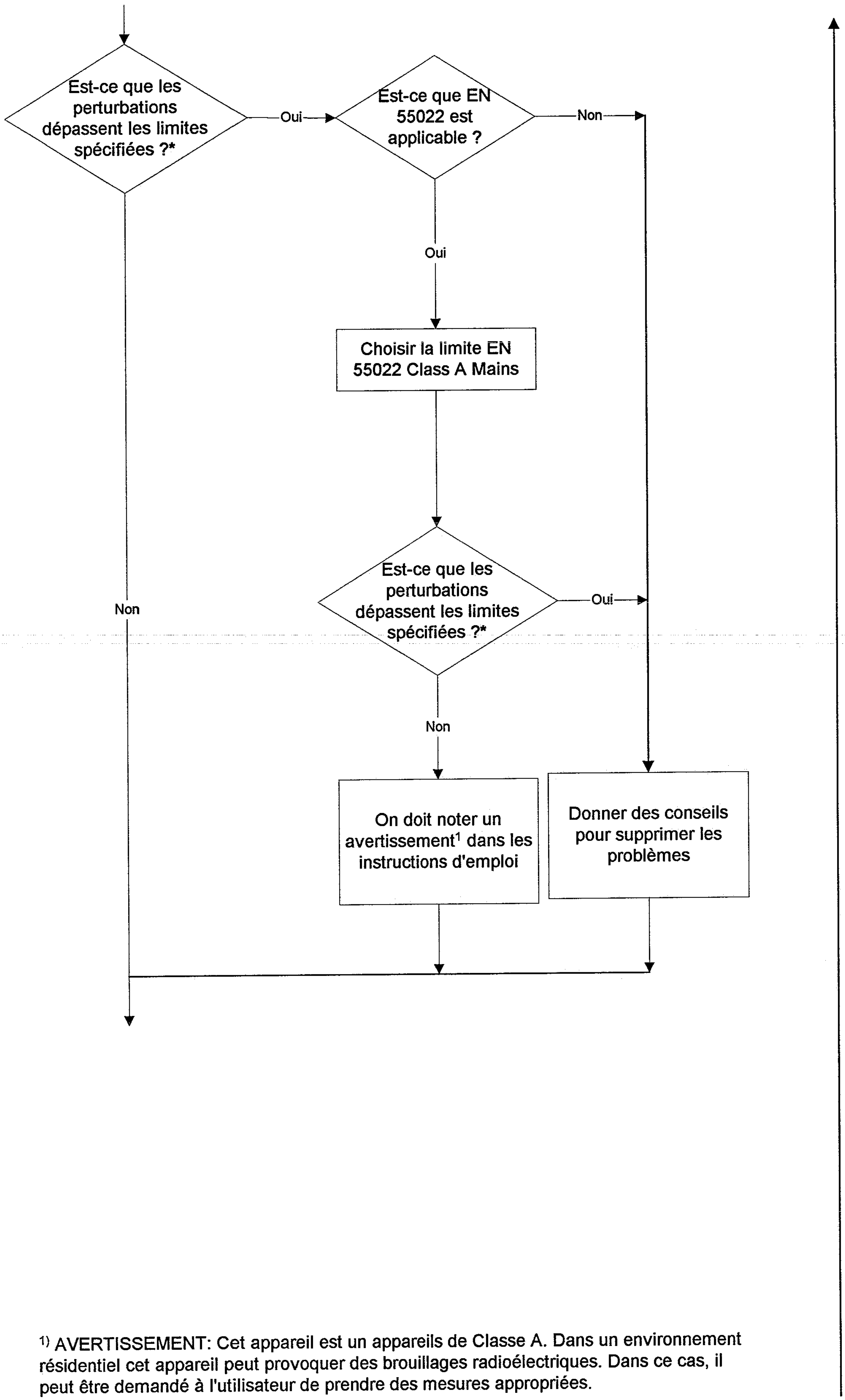
2) Par exemple un appareil à électro-érosion


L'appareil est-il destiné à être placé sur le sol ?
Non
Mettre l'appareil sur une table en bois, d'une hauteur de 0,8 mètres, comme montré dans la figure 2
Oui
Mettre l'appareil sur le plan de masse, comme montré dans la figure 2
Le fil d'alimentation, a-t-il une longueur de 1 mètre ?
Non
Est-il plus long ?
Non
Utiliser un câble d'un mètre
Oui
Réunir en faisceau les longueurs de câbles en excès au centre du câble, chaque faisceau mesurant 30 à 40 cm de longueur
Oui
Placer le LISN de telle manière que la distance entre l'appareil et le LISN est 0,8 mètres au minimum
Raccorder le fil d'alimentation au LISN

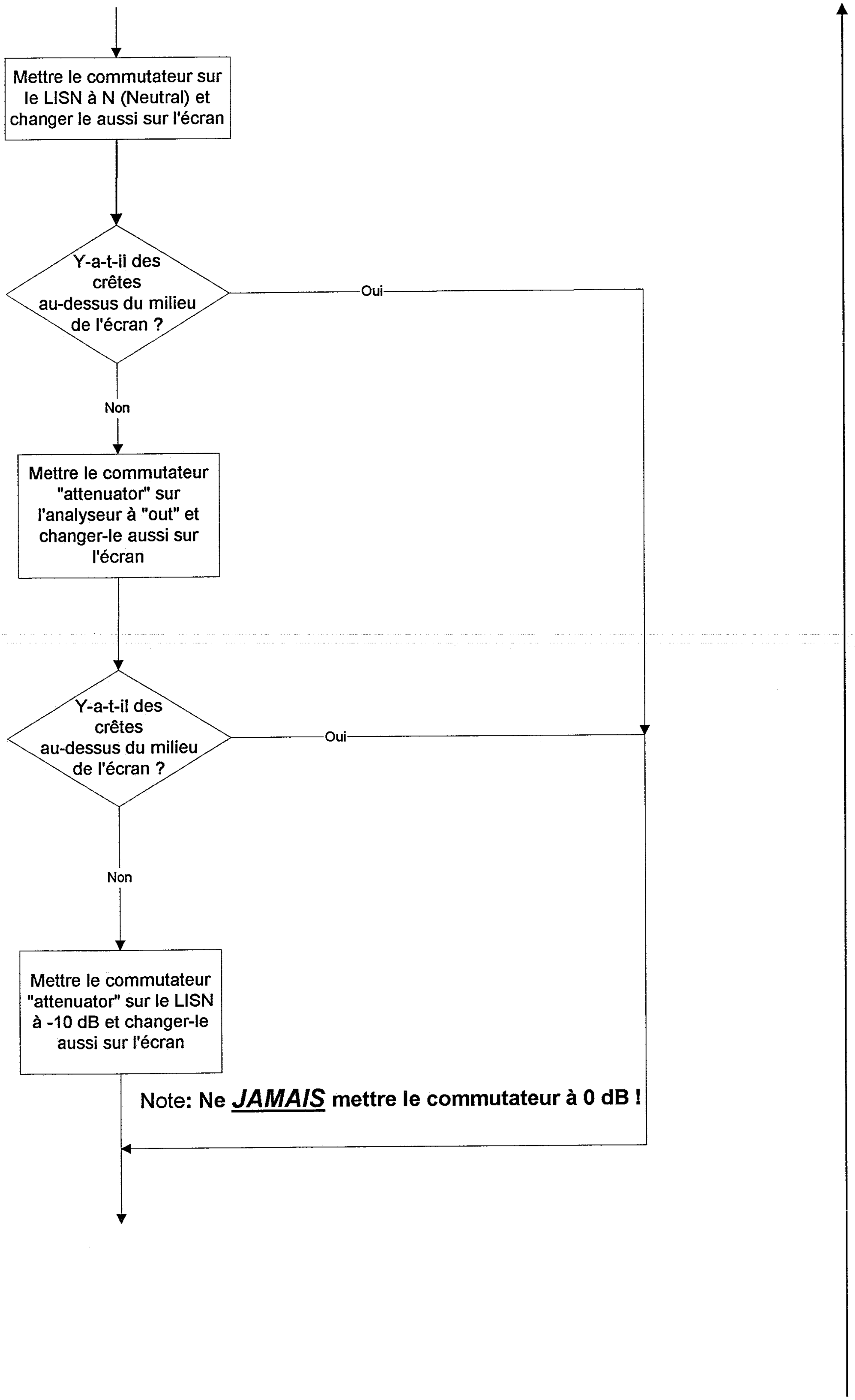


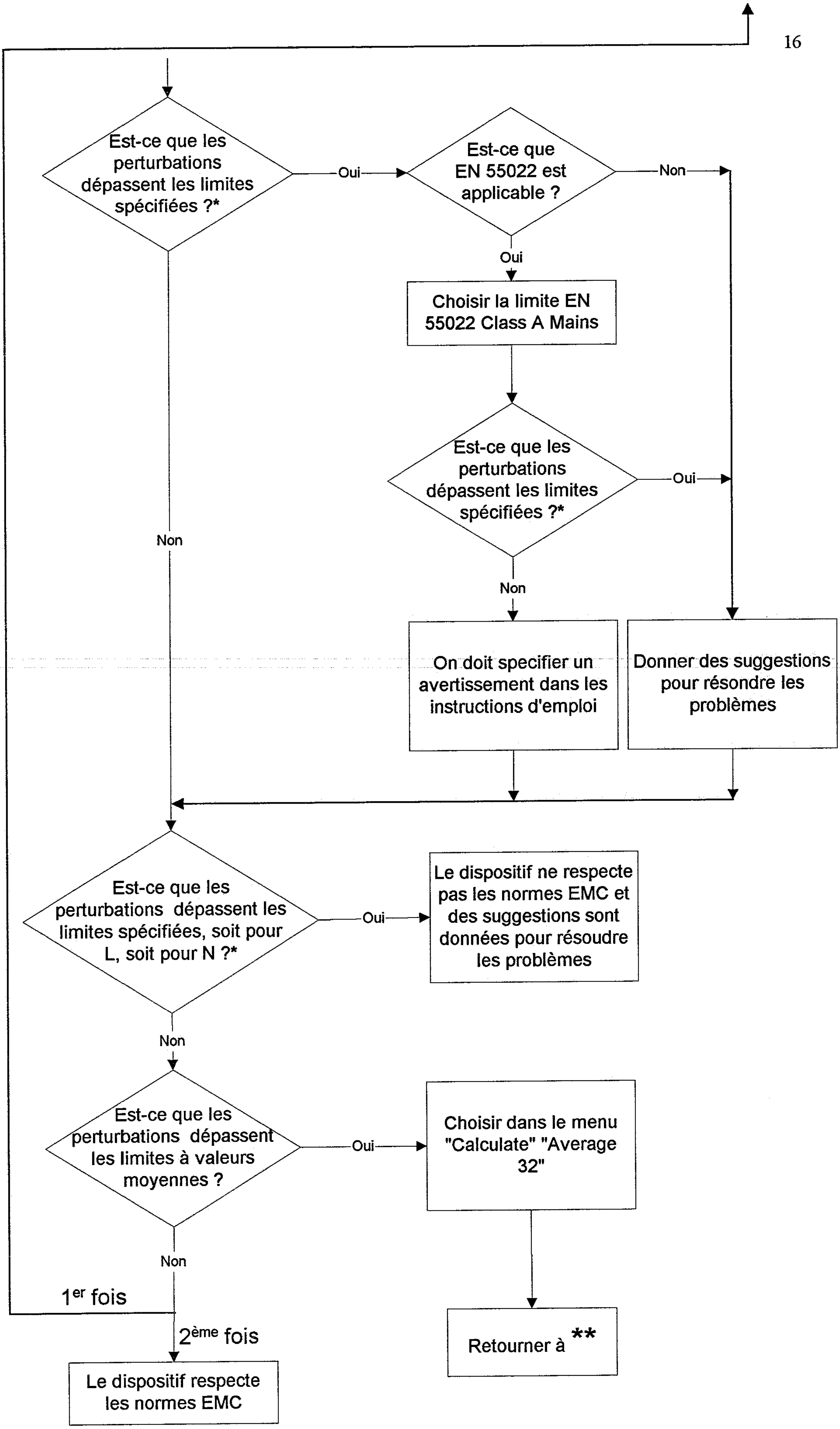
Régler le LISN comme suit:
Input: off
150 kHz filter: in
Attenuator: -20 dB
Connecter un câble entre la sortie du LISN et l'entrée de 50 Ohm de l'analyseur de spectre et mettre le commutateur "range" à 4.5 MHz
Régler l'analyseur comme suit:
* Attenuator: in
* Center frequenty: 2,50 MHz
* Scan mode: 500 kHz
* Filter: in
* B/width: narrow
* Baseline: complètement à gauche
* Sweeprate: complètement à droite
* Audio: complètement à gauche
Démarrer le logiciel et ouvrir le fichier "condte01.emc"
Choisir la limite appropriée:
- EN 55011 Cls A, Grp 1, mains
- EN 55011 Cls A, Grp 2, mains
- EN 55011 Cls B, Grp 1, mains
- EN 55011 Cls B, Grp 2, mains
- EN 55022 Class B mains
Si NF EN 55022 est applicable, choisir dans le menu "Calculate" "Quasi-peak"
Allumer le préamplificateur
Pousser "Run"
Allumer l'appareil
**
Mettre le commutateur sur le LISN à L (Live)
Connecter un câble entre la sortie du LISN et l'entrée de 50 Ohm de l'analyseur de spectre et mettre le commutateur "range" à 450 MHz
Régler l'analyseur comme suit:
* Attenuator: in
* Center frequenty: 25 MHz
* Scan mode: 5 MHz
* Filter: in
* B/width: wide
* Baseline: complètement à gauche
* Sweeprate: complètement à droite
* Audio: complètement à gauche
Démarrer le logiciel et ouvrir le fichier "condte02.emc"


Y-a-t-il des crêtes au-dessus du milieu de l'écran ?
Oui
Non
Mettre la commutateur "attenuator" sur l'analyseur à "out" et changer-le aussi sur l'écran
Y-a-t-il des crêtes au-dessus du milieu de l'écran ?
Oui
Non
Mettre la commutateur "attenuator" sur le LISN à -10 dB et changer-le aussi sur l'écran
Note: Ne JAMAIS mettre le commutateur à 0 dB !



1) AVERTISSEMENT: Cet appareil est un appareils de Classe A. Dans un environnement résidentiel cet appareil peut provoquer des brouillages radioélectriques. Dans ce cas, il peut être demandé à l'utilisateur de prendre des mesures appropriées.

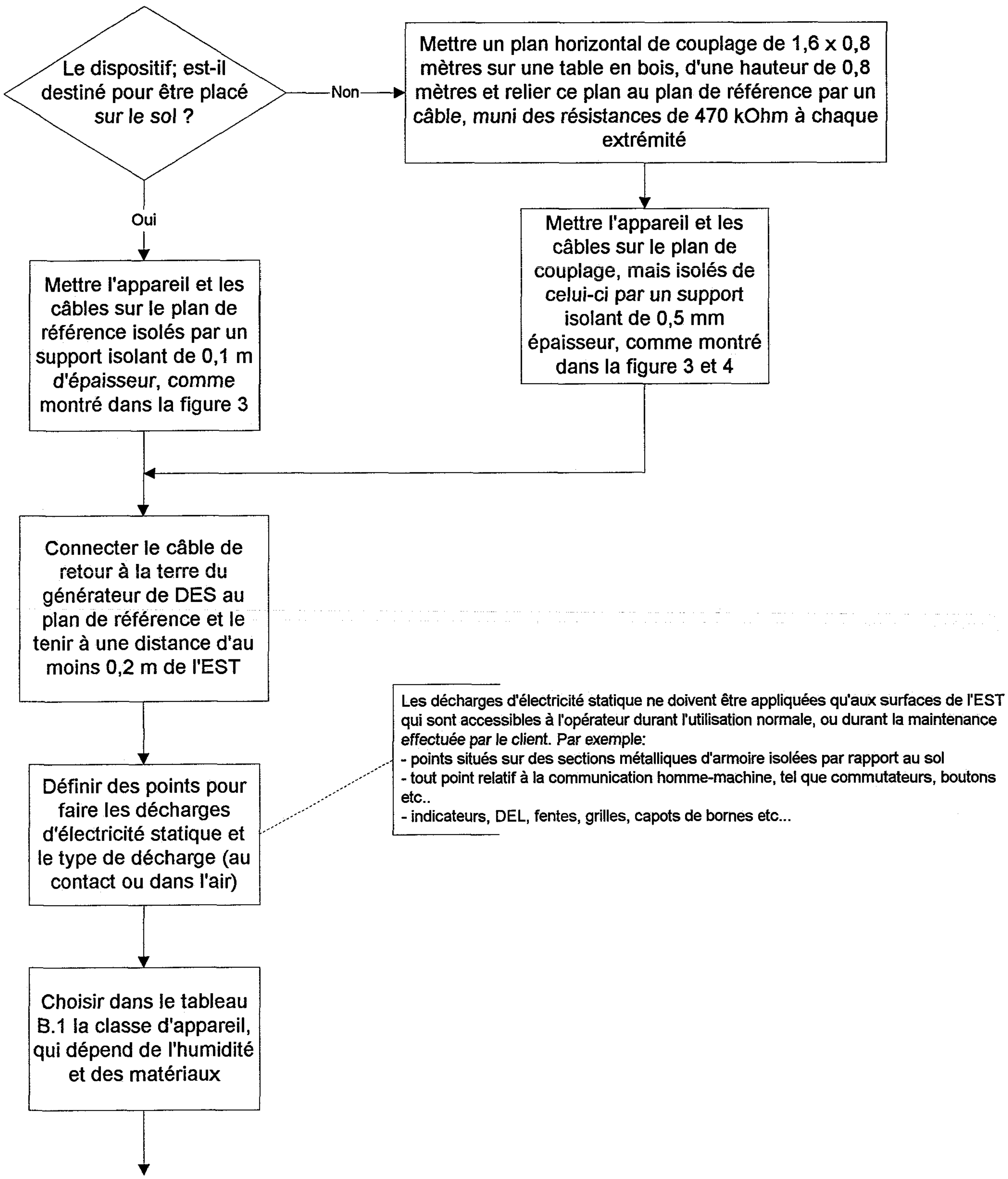

Mettre le commutateur sur le LISN à N (Neutral) et changer le aussi sur l'écran
Y-a-t-il des crêtes au-dessus du milieu de l'écran ?
Oui
Non
Mettre le commutateur "attenuator" sur l'analyseur à "out" et changer-le aussi sur l'écran
Y-a-t-il des crêtes au-dessus du milieu de l'écran ?
Oui
Non
Mettre le commutateur "attenuator" sur le LISN à -10 dB et changer-le aussi sur l'écran
Note: Ne JAMAIS mettre le commutateur à 0 dB !

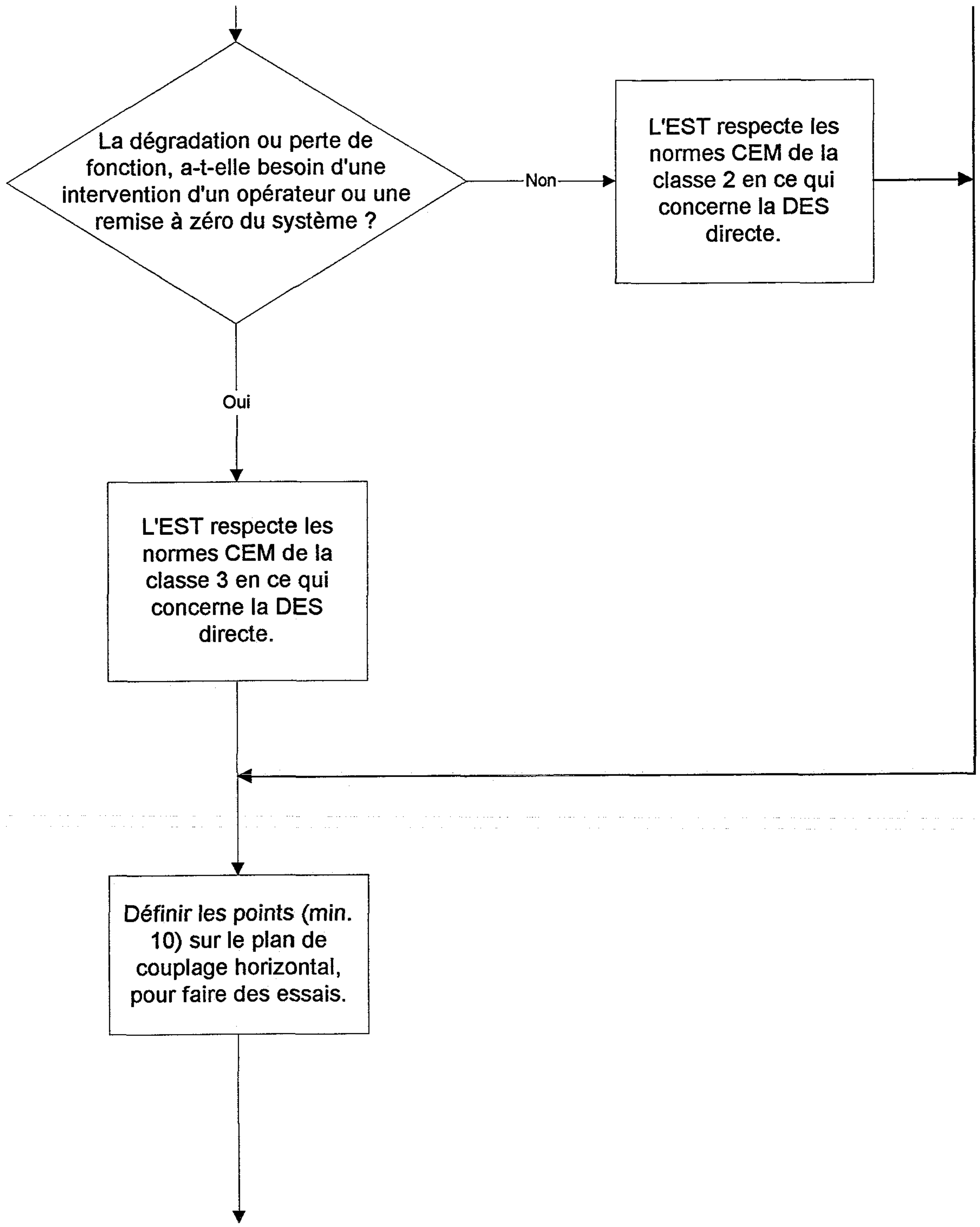


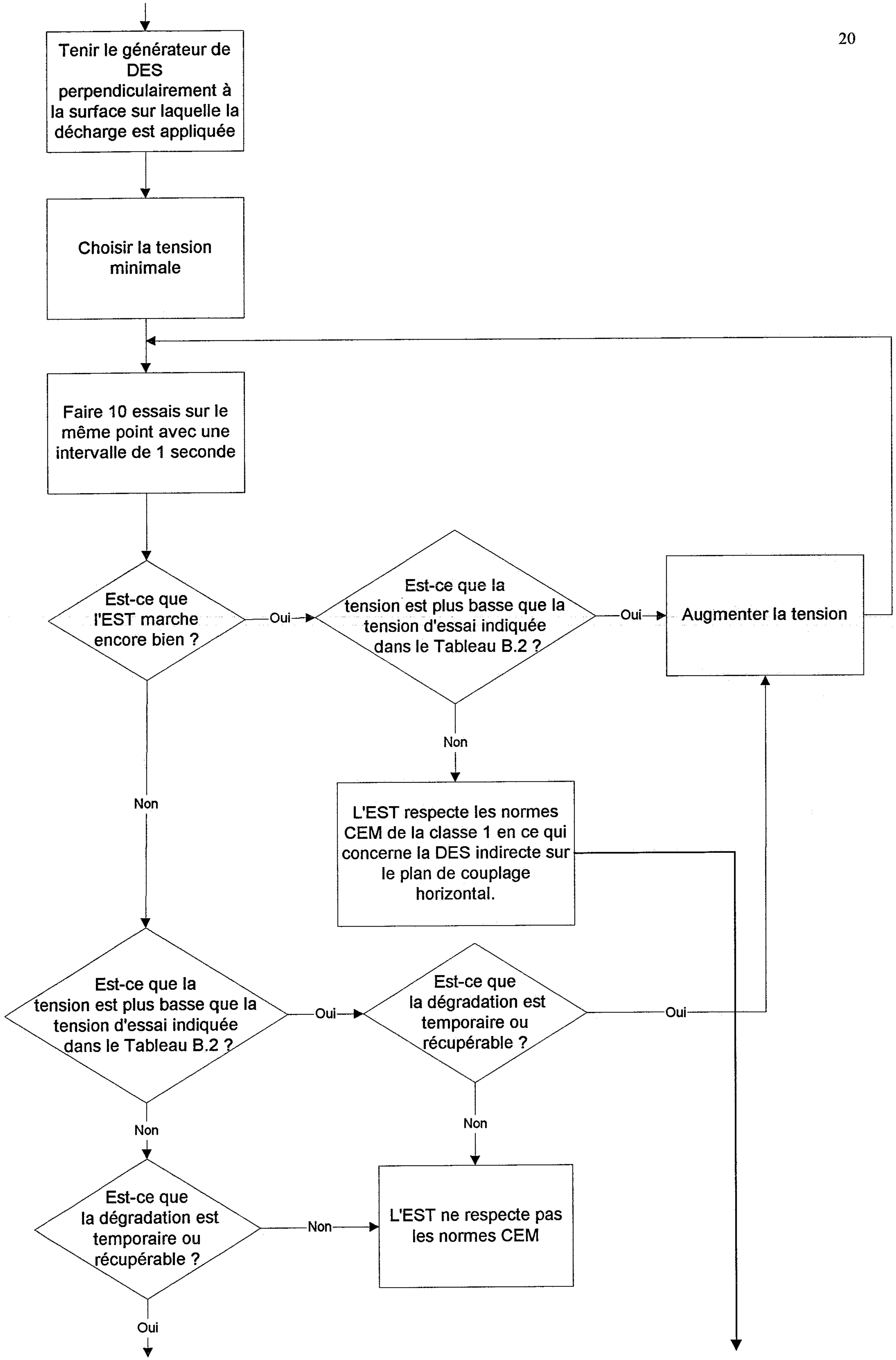
*) Si l'indication montre des fluctuations à proximité de la limite, cette indication diot être observée pendant 15 s: L'indication la plus élevée doit être notée

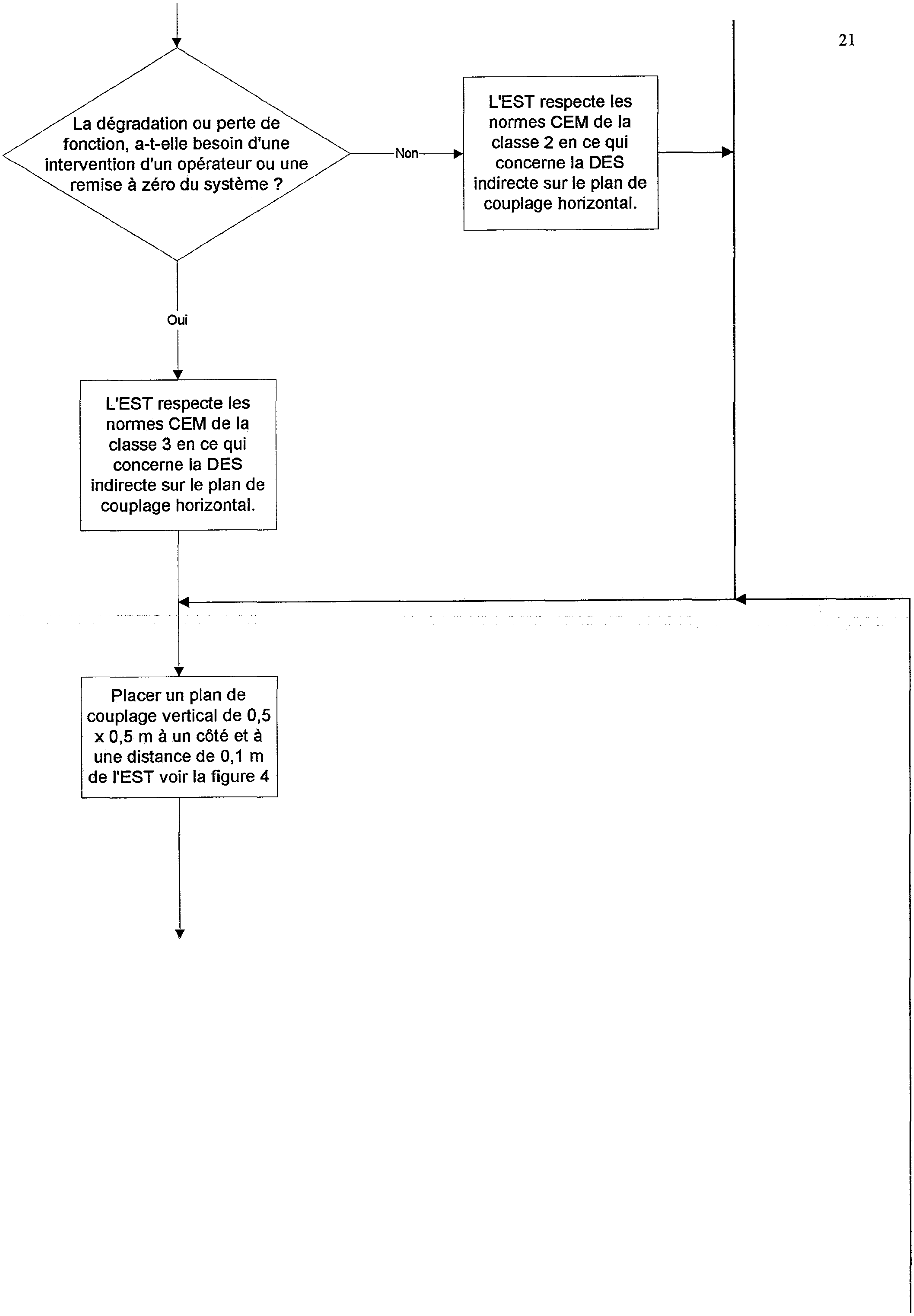
Dispositif à soumettre à un test

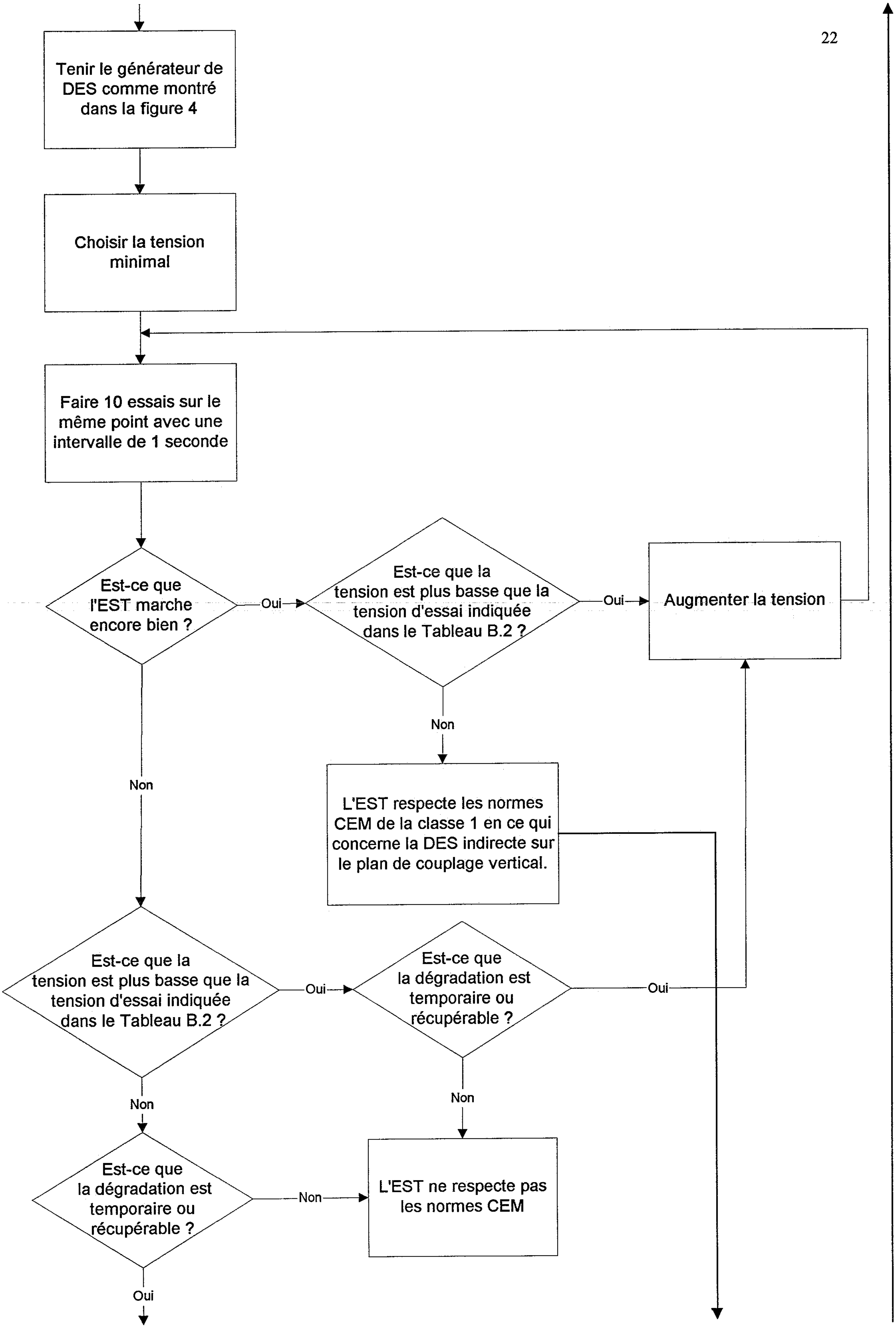
Immunité, décharges d'électricité statique (EN 61000-4-2)

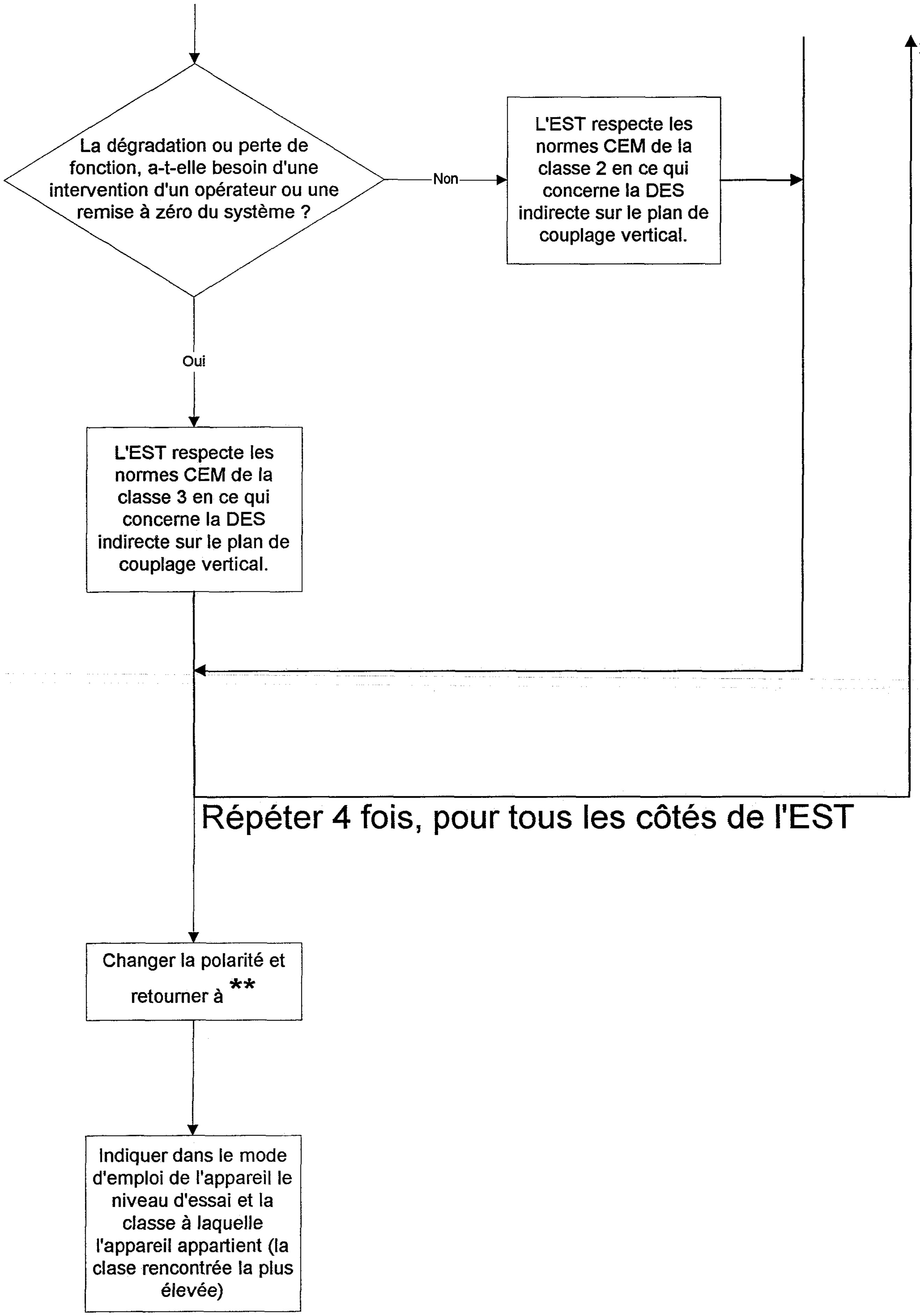



La dégradation ou perte de fonction, a-t-elle besoin d'une intervention d'un opérateur ou une remise à zéro du système ?
Non
L'EST respecte les normes CEM de la classe 2 en ce qui concerne la DES directe.
Oui
L'EST respecte les normes CEM de la classe 3 en ce qui concerne la DES directe.
Définir les points (min. 10) sur le plan de couplage horizontal, pour faire des essais.


Tenir le générateur de DES perpendiculairement à la surface sur laquelle la décharge est appliquée
Choisir la tension minimale
Faire 10 essais sur le même point avec une intervalle de 1 seconde
Est-ce que l'EST marche encore bien ?
Oui
Est-ce que la tension est plus basse que la tension d'essai indiquée dans le Tableau B.2 ?
Oui
Augmenter la tension
Non
L'EST respecte les normes CEM de la classe 1 en ce qui concerne la DES indirecte sur le plan de couplage horizontal.
Non
Est-ce que la tension est plus basse que la tension d'essai indiquée dans le Tableau B.2 ?
Oui
Est-ce que la dégradation est temporaire ou récupérable ?
Oui
Non
Non
Est-ce que la dégradation est temporaire ou récupérable ?
Non
L'EST ne respecte pas les normes CEM
Oui

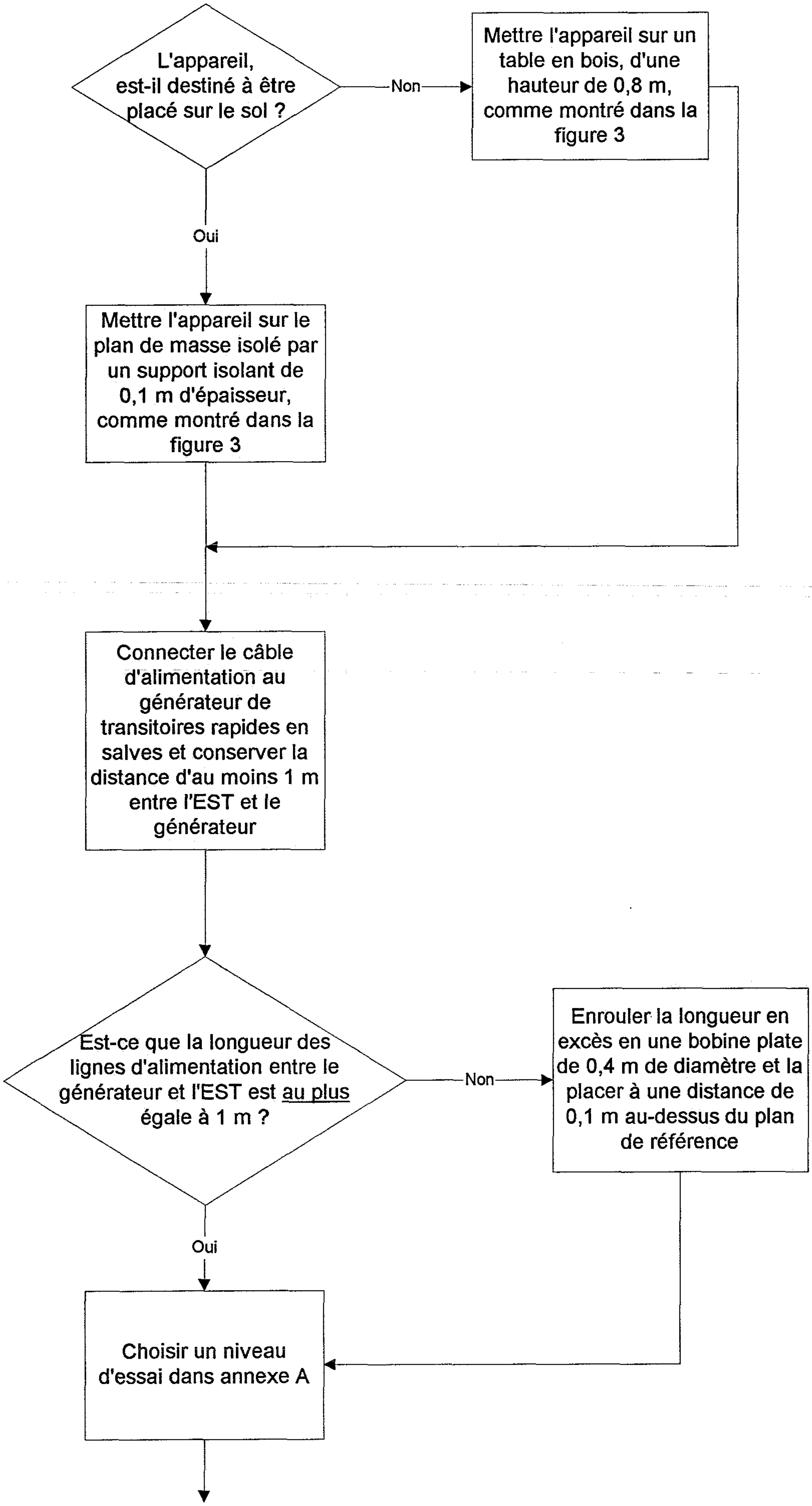

La dégradation ou perte de fonction, a-t-elle besoin d'une intervention d'un opérateur ou une remise à zéro du système ?
Non
L'EST respecte les normes CEM de la classe 2 en ce qui concerne la DES indirecte sur le plan de couplage horizontal.
Oui
L'EST respecte les normes CEM de la classe 3 en ce qui concerne la DES indirecte sur le plan de couplage horizontal.
Placer un plan de couplage vertical de 0,5 x 0,5 m à un côté et à une distance de 0,1 m de l'EST voir la figure 4

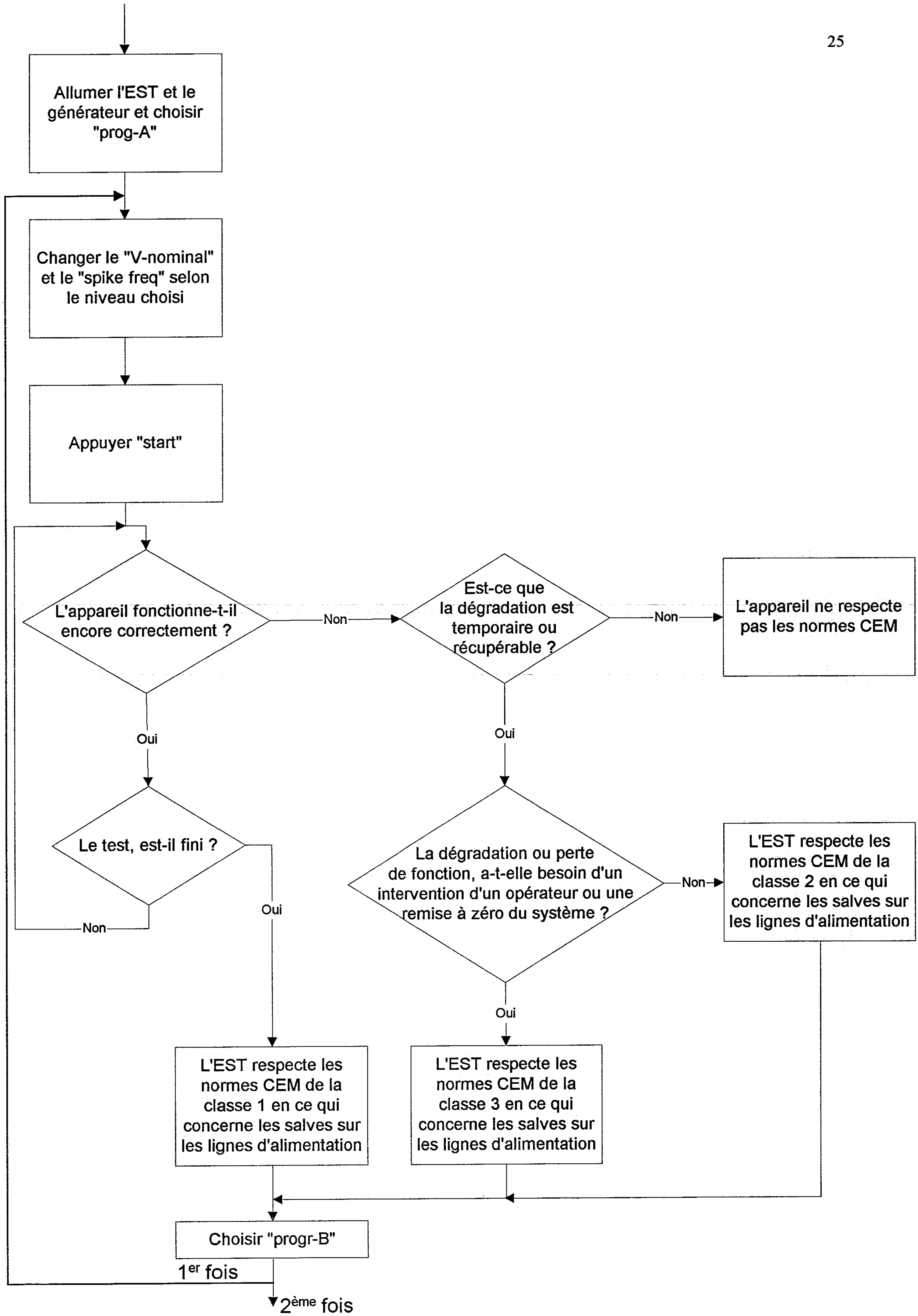

Tenir le générateur de DES comme montré dans la figure 4
Choisir la tension minimal
Faire 10 essais sur le même point avec une intervalle de 1 seconde
Est-ce que l'EST marche encore bien ?
Oui
Est-ce que la tension est plus basse que la tension d'essai indiquée dans le Tableau B.2 ?
Oui
Augmenter la tension
Non
L'EST respecte les normes CEM de la classe 1 en ce qui concerne la DES indirecte sur le plan de couplage vertical.
Non
Est-ce que la tension est plus basse que la tension d'essai indiquée dans le Tableau B.2 ?
Oui
Est-ce que la dégradation est temporaire ou récupérable ?
Oui
Non
Non
Est-ce que la dégradation est temporaire ou récupérable ?
Non
L'EST ne respecte pas les normes CEM
Oui

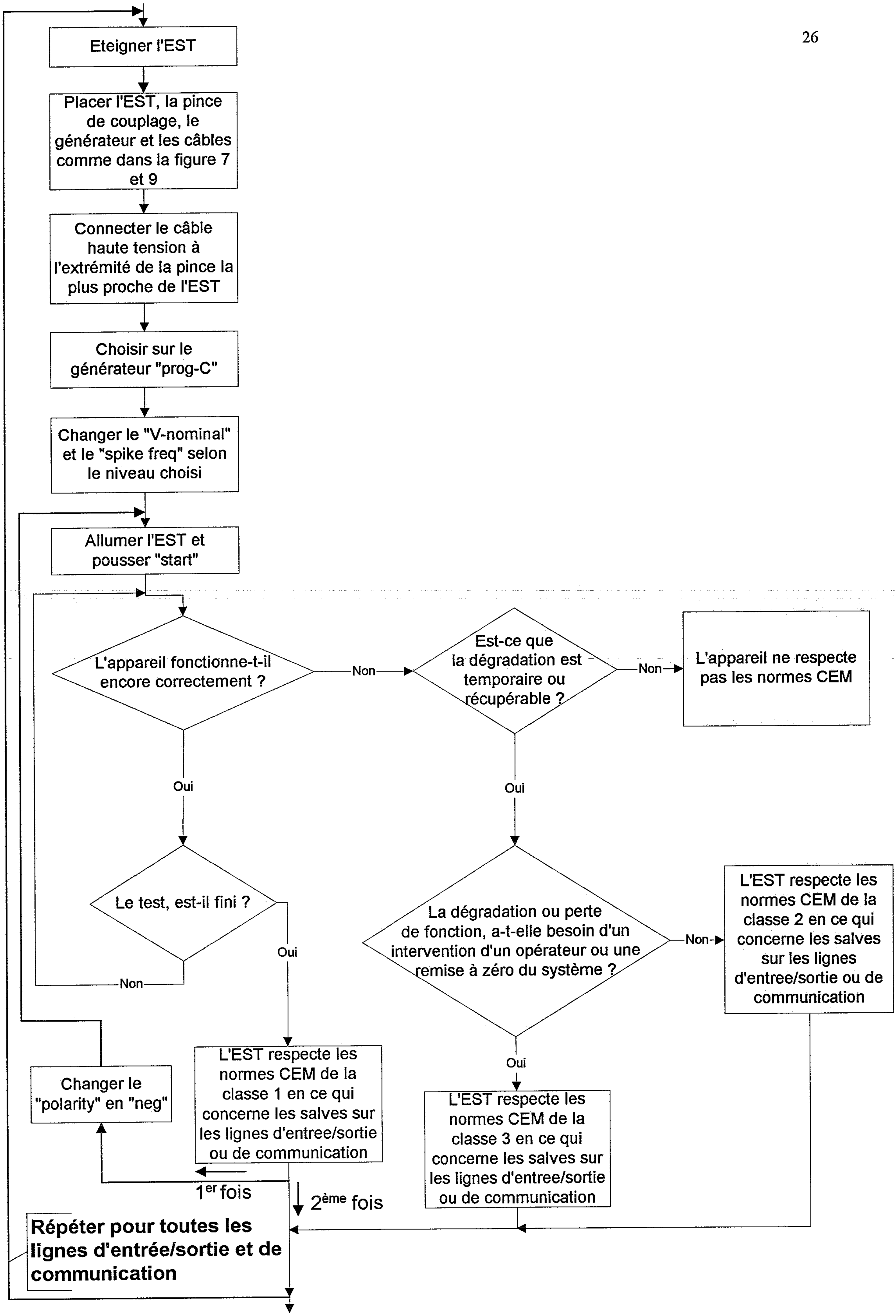

La dégradation ou perte de fonction, a-t-elle besoin d'une intervention d'un opérateur ou une remise à zéro du système ?
Non
L'EST respecte les normes CEM de la classe 2 en ce qui concerne la DES indirecte sur le plan de couplage vertical.
Oui
L'EST respecte les normes CEM de la classe 3 en ce qui concerne la DES indirecte sur le plan de couplage vertical.
Répéter 4 fois, pour tous les côtés de l'EST
Changer la polarité et retourner à **
Indiquer dans le mode d'emploi de l'appareil le niveau d'essai et la classe à laquelle l'appareil appartient (la clase rencontrée la plus élevée)

Dispositif à soumettre à un test

Immunité, transitoires électriques rapides en salves (EN 61000-4-4)




Allumer l'EST et le générateur et choisir "prog-A"
Changer le "V-nominal" et le "spike freq" selon le niveau choisi
Appuyer "start"
L'appareil fonctionne-t-il encore correctement ?
Non
Est-ce que la dégradation est temporaire ou récupérable ?
Non
L'appareil ne respecte pas les normes CEM
Oui
Oui
Le test, est-il fini ?
Non
Oui
La dégradation ou perte de fonction, a-t-elle besoin d'un intervention d'un opérateur ou une remise à zéro du système ?
Non
L'EST respecte les normes CEM de la classe 2 en ce qui concerne les salves sur les lignes d'alimentation
Oui
L'EST respecte les normes CEM de la classe 1 en ce qui concerne les salves sur les lignes d'alimentation
L'EST respecte les normes CEM de la classe 3 en ce qui concerne les salves sur les lignes d'alimentation
Choisir "progr-B"
1er fois
2ème fois


Eteigner l'EST
Placer l'EST, la pince de couplage, le générateur et les câbles comme dans la figure 7 et 9
Connecter le câble haute tension à l'extrémité de la pince la plus proche de l'EST
Choisir sur le générateur "prog-C"
Changer le "V-nominal" et le "spike freq" selon le niveau choisi
Allumer l'EST et pousser "start"
L'appareil fonctionne-t-il encore correctement ?
Non
Est-ce que la dégradation est temporaire ou récupérable ?
Non
L'appareil ne respecte pas les normes CEM
Oui
Oui
Le test, est-il fini ?
Non
Oui
La dégradation ou perte de fonction, a-t-elle besoin d'un intervention d'un opérateur ou une remise à zéro du système ?
Non
L'EST respecte les normes CEM de la classe 2 en ce qui concerne les salves sur les lignes d'entree/sortie ou de communication
Oui
Changer le "polarity" en "neg"
L'EST respecte les normes CEM de la classe 1 en ce qui concerne les salves sur les lignes d'entree/sortie ou de communication
L'EST respecte les normes CEM de la classe 3 en ce qui concerne les salves sur les lignes d'entree/sortie ou de communication
1er fois
2ème fois
Répéter pour toutes les lignes d'entrée/sortie et de communication

Indiquer dans le mode d'emploi de l'appareil le niveau de l'essai et à la classe à laquelle l'appareil appartient (la plus haute classe la plus élevée)

2. Figures

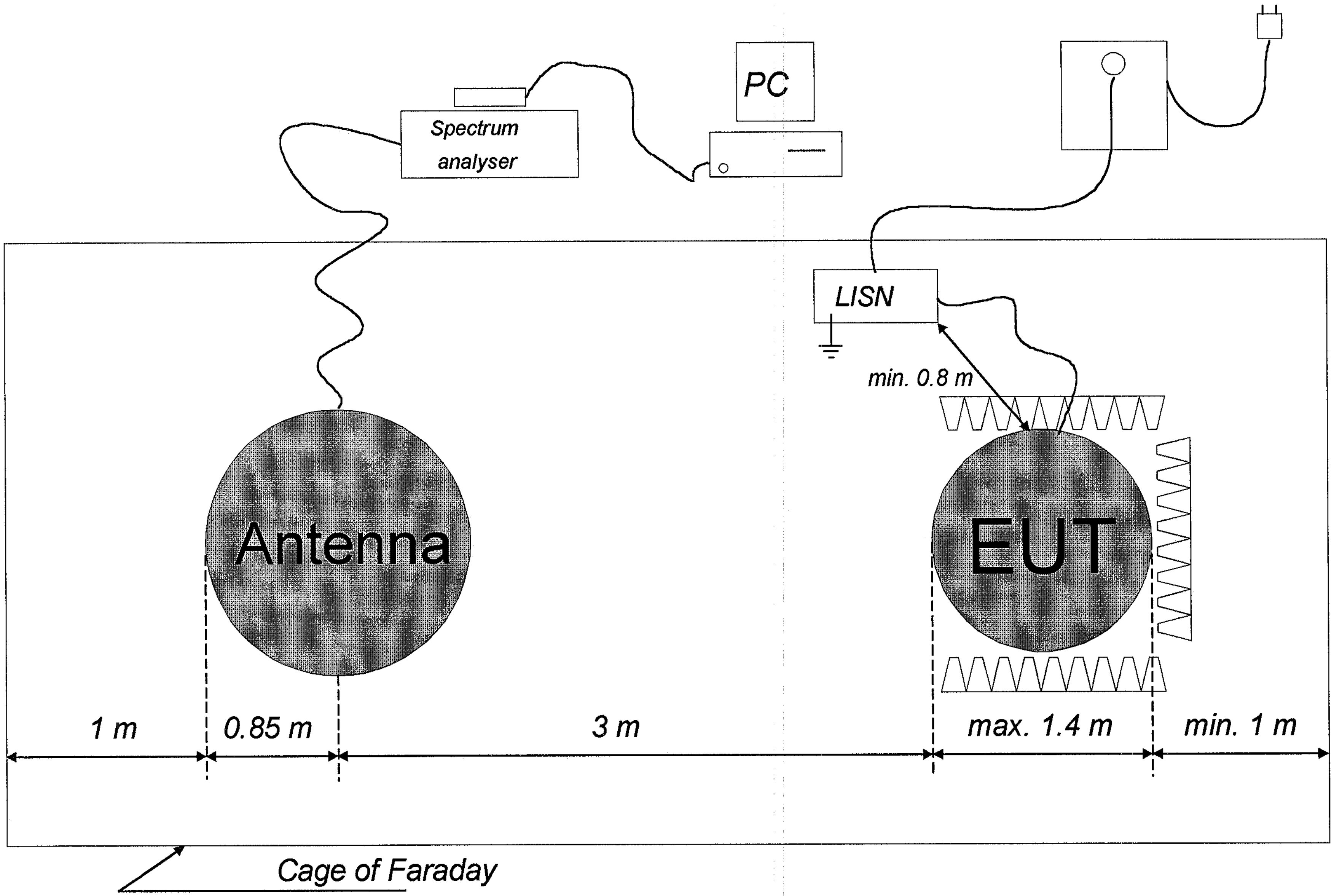


Figure 1: *Installation des appareils de mesures pour l'émission rayonnant*

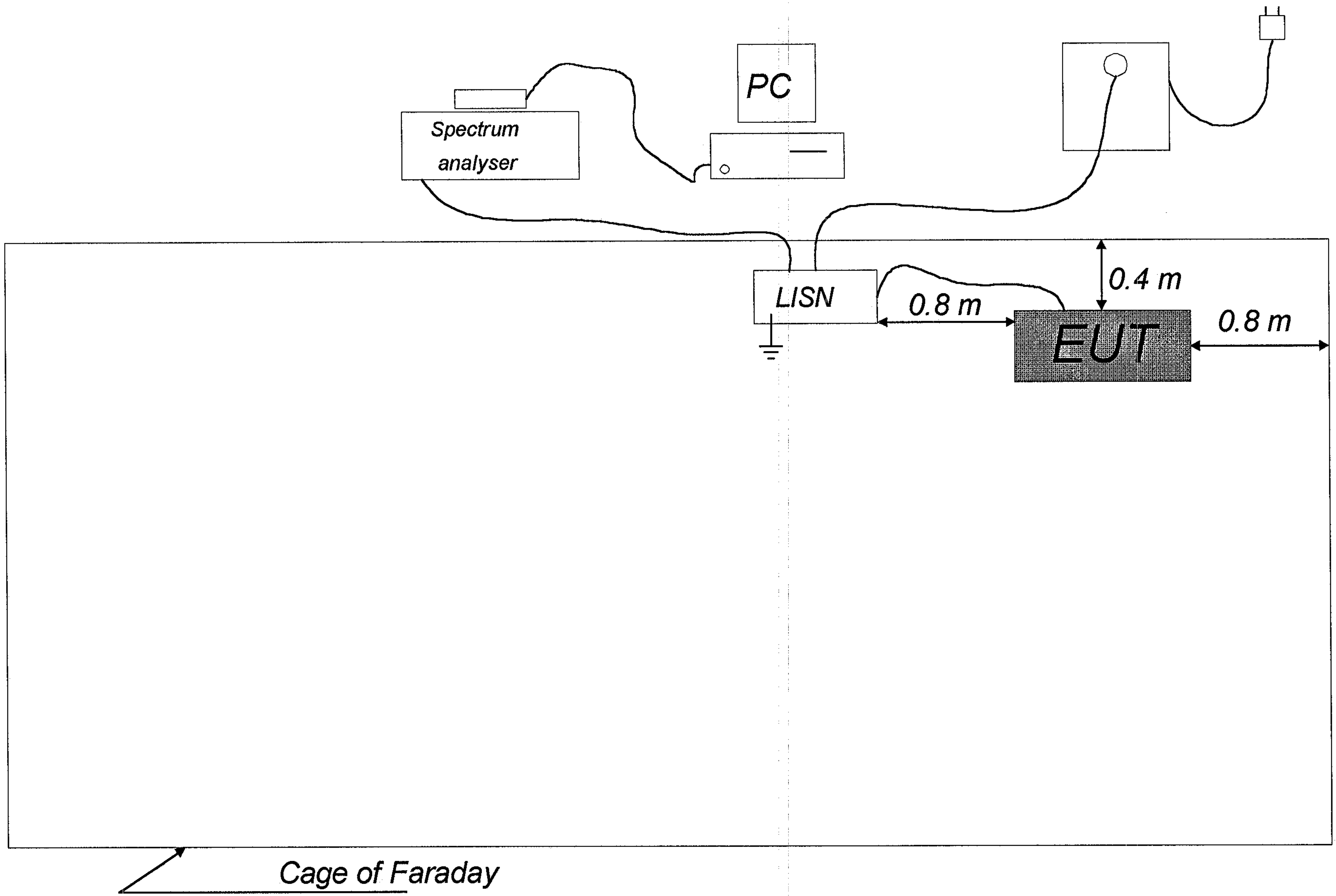


Figure 2: *Installation des appareils de mesures pour l'émission conduit*

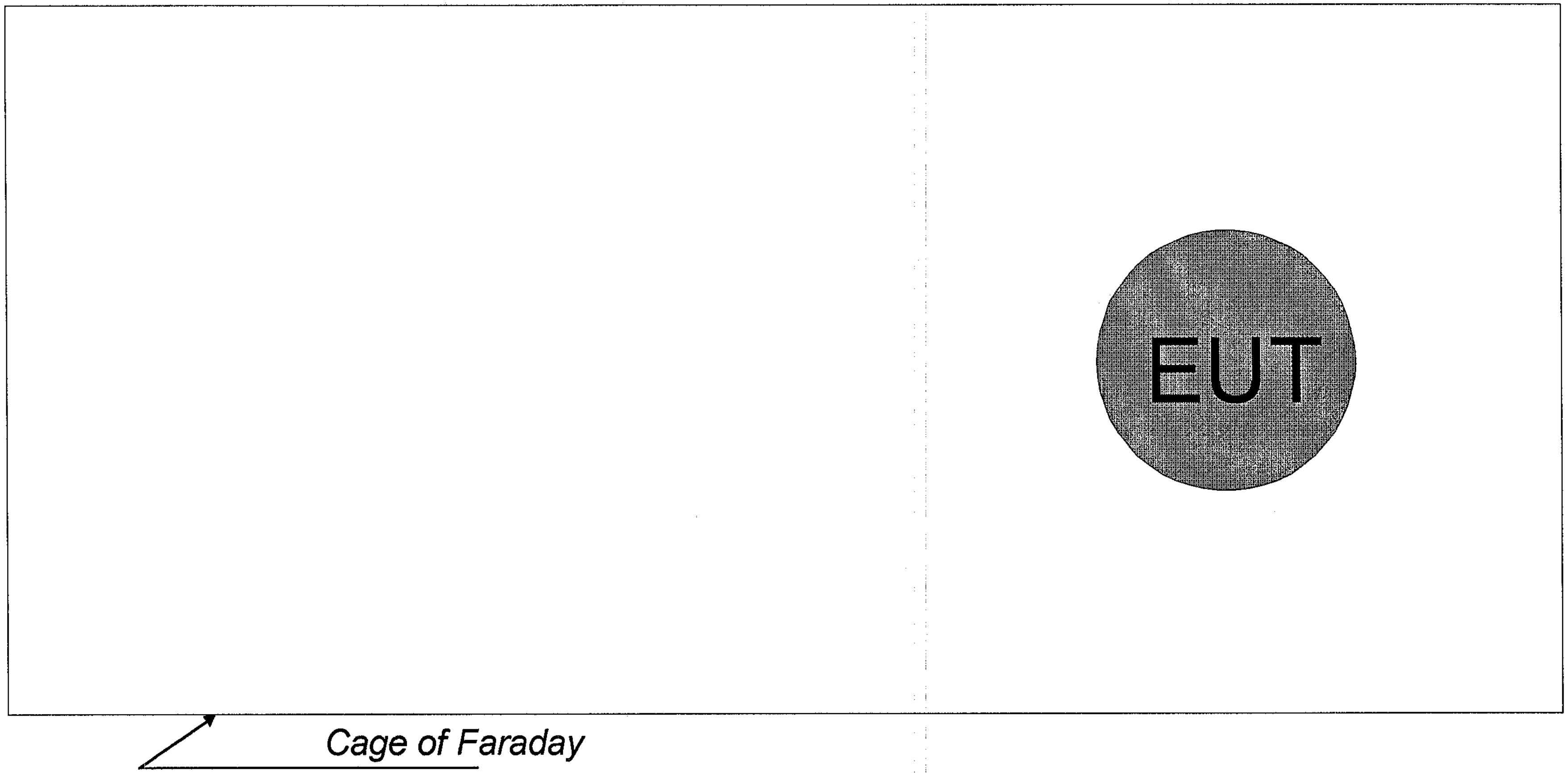


Figure 3: *Installation des appareils de mesures pour les essais de l'immunité*

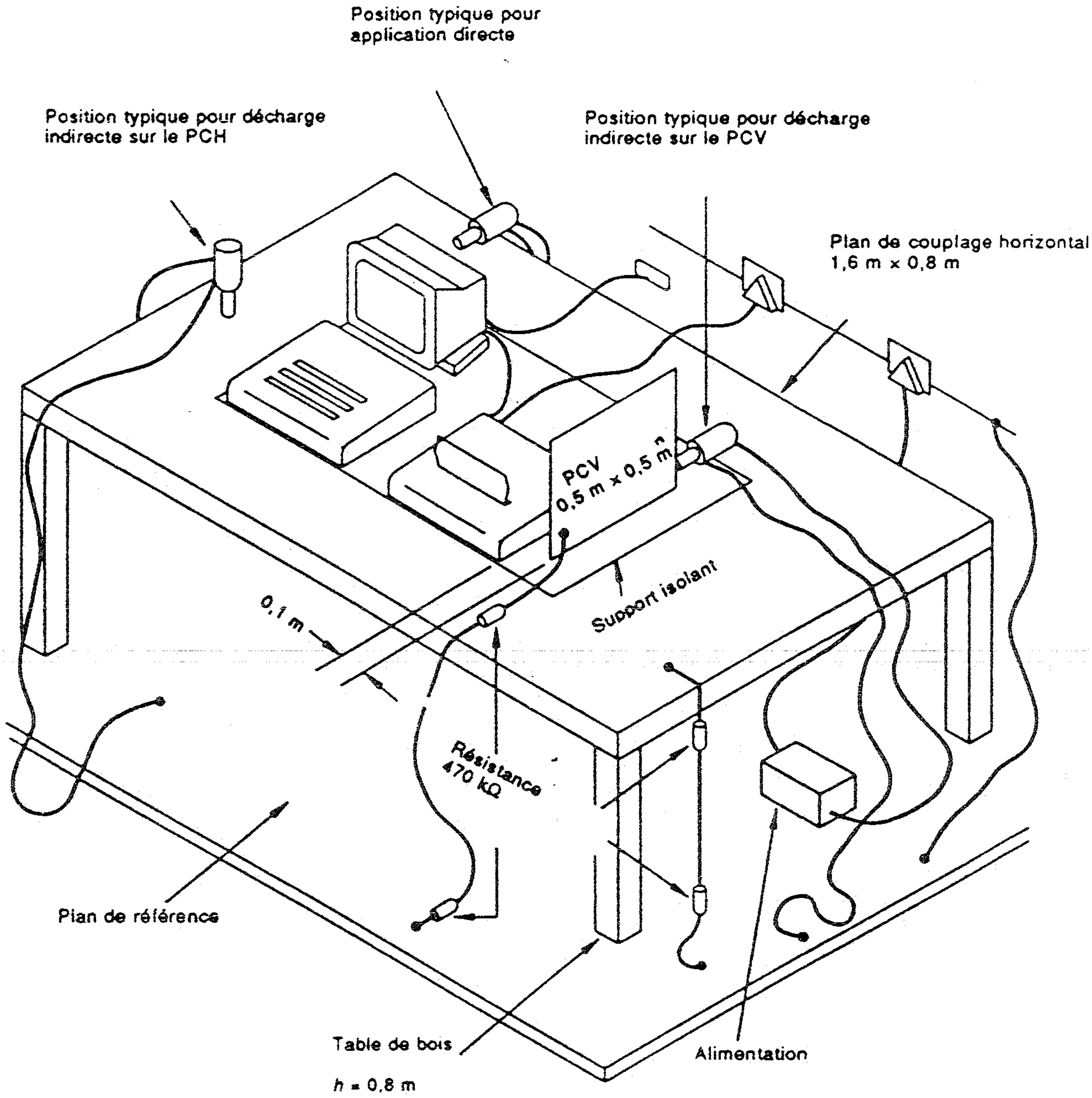


Figure 5 – Exemple d'installation d'essai pour matériel de table, essais en laboratoire

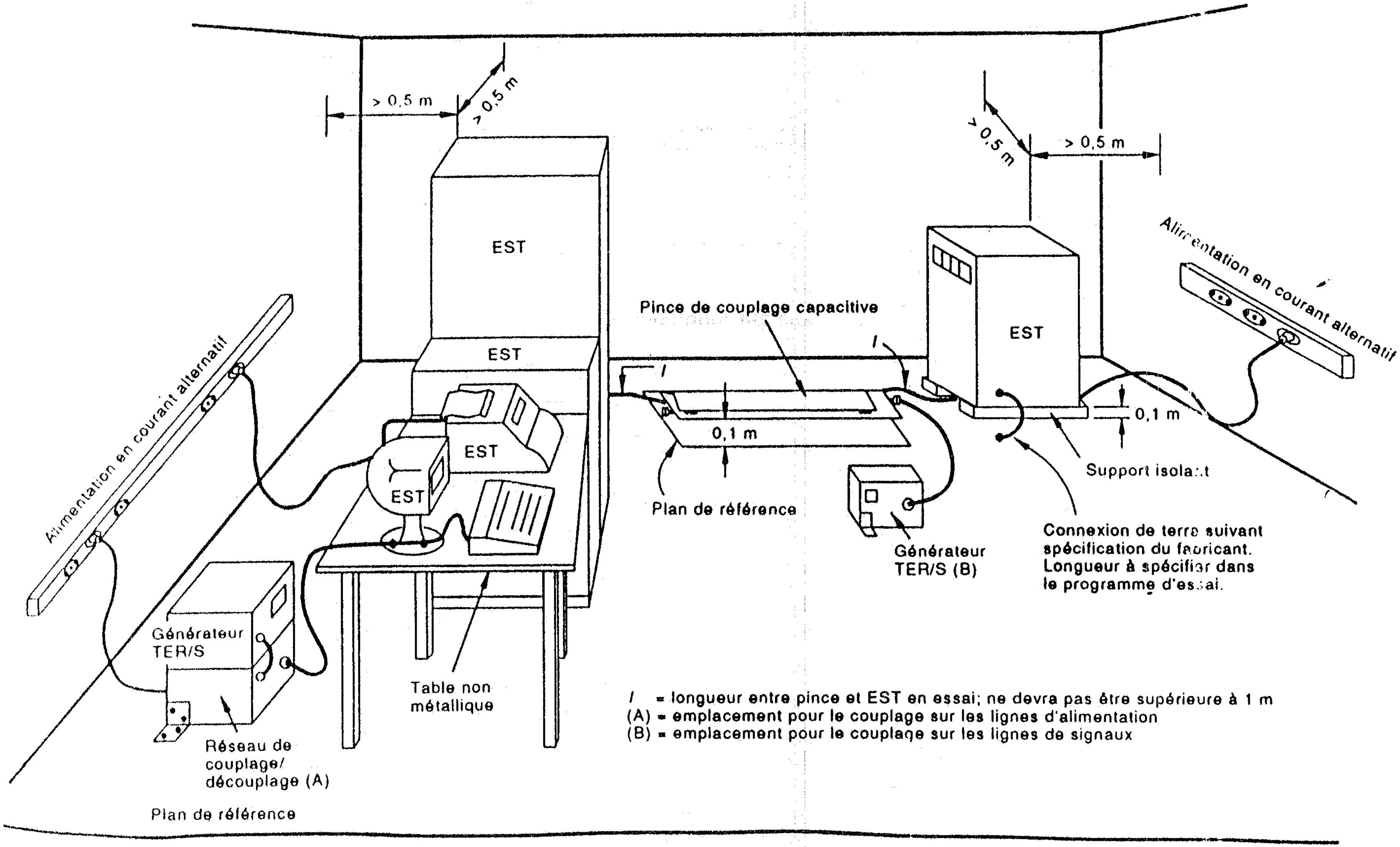


Figure 7 – Montage général d'essai pour les essais de type en laboratoire

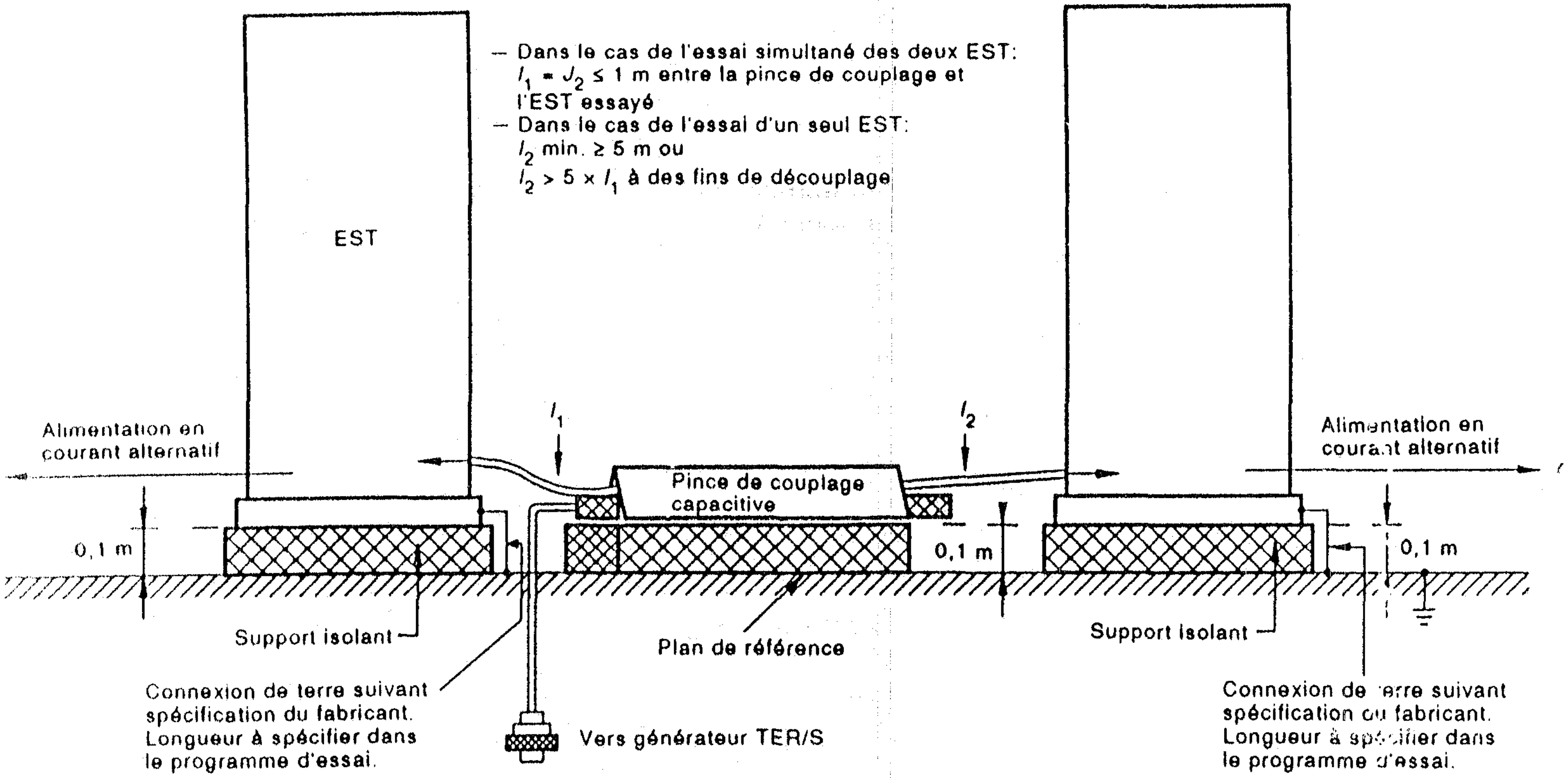


Figure 9 – Exemple de montage d'essai pour l'application de la tension d'essai au moyen de la pince de couplage capacitive pour les essais en laboratoire

3. Annexes

Annexe A
(informative)

Notes explicatives sur le générateur de transitoires rapides en salves et sur la sélection des niveaux de sévérité d'essai

Une longue expérience de la pratique des essais d'immunité sur le matériel électrique et électronique a montré que pour couvrir suffisamment la grande diversité des perturbations électriques et électromagnétiques, il est nécessaire de disposer d'un essai simulant des transitoires rapides à grande fréquence de répétition. Ceci est bien connu des experts CEM et nombre d'entreprises ont développé un tel essai.

Malheureusement, les paramètres importants du générateur d'essai et du montage d'essai sont largement différents et les résultats d'essai ne peuvent pas être comparés les uns aux autres. Cette situation crée des problèmes si des matériels de différents niveaux d'immunité et provenant de différents fabricants sont intégrés dans un système, dans un environnement électromagnétique donné.

Ces prescriptions furent parmi les principaux facteurs qui ont mené à la préparation de cette norme.

A.1 Générateur de transitoires rapides en salves

Pour éliminer les ambiguïtés qui pourraient résulter d'écarts entre les caractéristiques de divers générateurs d'essai, il est nécessaire d'appliquer une procédure d'étalonnage ou d'essai normalisée. On mesurera les caractéristiques significatives du générateur d'essai (voir 6.1.2) lors de l'application de transitoires rapides en salves sur une charge résistive de 50 Ω (réponse en fréquence plate jusqu'à 400 MHz).

En raison de l'instabilité mécanique et électrique de l'éclateur au-dessous de 1 kV, on pourra obtenir les tensions d'essai inférieures à 2 kV à partir de diviseurs de tension.

Dans la réalité, le phénomène de salve se produit avec des fréquences de répétition des impulsions de 10 kHz à 1 MHz. Cependant, des investigations menées sur une large échelle ont montré que cette fréquence de répétition relativement élevée est difficile à reproduire avec un générateur fonctionnant avec un éclateur à réglage fixe. De ce fait, des fréquences de répétition plus basses (mais avec des impulsions individuelles représentatives) ont été spécifiées en 6.1.2.

La variation de la fréquence de répétition des impulsions avec le degré de sévérité choisi tient compte du comportement particulier de la circuiterie de cet éclateur.

A.2 Sélection des niveaux de sévérité d'essai

Il y a lieu de choisir les niveaux de sévérité d'essai en concordance avec les conditions d'environnement et d'installation les plus réalistes. Ces niveaux sont indiqués dans l'article 5 de la présente norme

Les essais d'immunité sont corrélés avec ces niveaux afin d'établir un niveau de fonctionnement pour l'environnement dans lequel il est prévu que les matériels doivent fonctionner.

Pour les accès d'entrée/sortie de commande, de signal et de données, on utilisera des valeurs de tension d'essai moitié de celles appliquées sur les accès d'alimentation

La recommandation concernant la sélection des niveaux des essais TER/S en fonction de ce qu'impose l'environnement électromagnétique, fondée sur l'observation des pratiques courantes en matière d'installation, est la suivante:

Niveau 1: Environnement bien protégé

L'installation est caractérisée de la manière suivante:

- suppression de tous les TER/S dans les circuits d'alimentation et de commande commutés;
- séparation entre les lignes d'alimentation courant alternatif et courant continu et les circuits de commande et de mesure provenant d'autres environnements appartenant à des niveaux de sévérité plus élevés;
- câbles d'alimentation blindés avec écrans mis à la terre aux deux extrémités, à la terre de référence de l'installation, protection de l'alimentation par filtrage.

La salle d'ordinateurs peut être représentative de cet environnement.

L'application de ce niveau pour l'essai de l'équipement se limite aux circuits d'alimentation pour les essais de type, et aux circuits de mise à la terre et aux armoires d'équipements pour les essais sur site.

Niveau 2: Environnement protégé

L'installation est caractérisée de la manière suivante:

- suppression partielle des TER/S dans les circuits d'alimentation et de commande, qui ne sont commutés uniquement que par des relais (pas de contacteurs);
- séparation entre tous les circuits appartenant à cet environnement protégé et les autres circuits provenant d'environnements ayant des niveaux de sévérité plus élevés;
- séparation physique entre les câbles d'alimentation et de commande non blindés et les câbles de signal et de communication.

La salle de commande ou la salle des terminaux des installations industrielles et électriques peut être représentative de cet environnement.

Niveau 3: Environnement industriel typique

L'installation est caractérisée de la manière suivante:

- pas de suppression des TER/S dans les circuits d'alimentation et de commande qui ne sont commutés uniquement que par des relais (pas de contacteurs);
- séparation insuffisante entre les circuits appartenant à l'environnement industriel et les circuits relevant de niveaux de sévérité plus élevés;
- câbles spécialisés pour l'alimentation, la commande, les lignes de signal et de communication;
- séparation insuffisante entre les câbles d'alimentation, de commande, de signal et de communication;
- disponibilité d'un système de mise à la terre comportant des tuyaux conducteurs, des conducteurs de terre dans les chemins de câbles (connectés à la terre de protection) et un réseau de terre maillé.

Peuvent être considérés comme représentatifs de cet environnement les équipements de processus industriels, les centrales électriques et les salles de relayage des postes H.T en plein air

Niveau 4: Environnement industriel sévère

L'installation est caractérisée de la manière suivante:

- pas de suppression des TER/S dans les circuits d'alimentation et de commande et les circuits de puissance, qui sont commutés par des relais et par des contacteurs;
- pas de séparation entre les circuits appartenant à l'environnement industriel sévère et les autres circuits appartenant à un environnement d'un niveau de sévérité plus élevé;
- pas de séparation entre les câbles d'alimentation, de commande, de signal et de communication;
- utilisation de câbles multiconducteurs communs aux lignes de commande et de signal.

Sont représentatives de cet environnement les zones extérieures des équipements de processus industriels, pour lesquelles aucune protection spécifique n'a été adoptée, des centrales électriques, les postes H.T. en plein air et l'appareillage à isolation gazeuse fonctionnant à des tensions pouvant atteindre 500 kV (avec leurs propres règles d'installation).

Niveau 5: Situations particulières à analyser

La bonne ou mauvaise séparation électromagnétique des sources de perturbation des circuits, câbles, lignes, des matériels, etc., et la qualité des installations peuvent conduire à choisir un niveau d'environnement plus élevé ou plus faible que ceux qui ont été décrits plus haut. Il faut faire attention au fait que certaines lignes issues d'un environnement d'un niveau de sévérité plus élevé peuvent être introduites dans un environnement de sévérité moindre.

Niveaux d'essai

Niveau	Sur l'accès d'alimentation de puissance, PE		Sur les signaux Entree/Sortie, les accès de données et de contrôle	
	Tension de crête kV	Fréquence de répétition kHz	Tension de crête kV	Fréquence de répétition kHz
1	0,5	5	0,25	5
2	1	5	0,5	5
3	2	5	1	5
4	4	2,5	2	5

Tableau A.1: *Niveaux d'essai pour l'immunité aux transitoires électriques rapides en salves*

Annexe B

Tableau B.1 - Conseils pour le choix des niveaux d'essais

Classe	Humidité relative pouvant descendre jusu'à %	Matériaux antistatiques	Matériaux synthétiques	Tension maximale kV
1	35	x		2
2	10	x		4
3	50		x	8
4	10		x	15

Tableau B.2 - Niveaux d'essai

1a - Décharge au contact		1b - Décharge dans l'air	
Niveau	Tension d'essai kV	Niveau	Tension d'essai kV
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15

Annexe C

Contenu des fichiers CEM et des programmes dans le générateur de salves.

Dans les pages suivantes sont montrés les réglages préprogrammés du logiciel pour mesurer l'émission et du générateur de salves.

Current Settings Summary

File: RAYONN01.EMC

Summary of present EMC Engineer settings

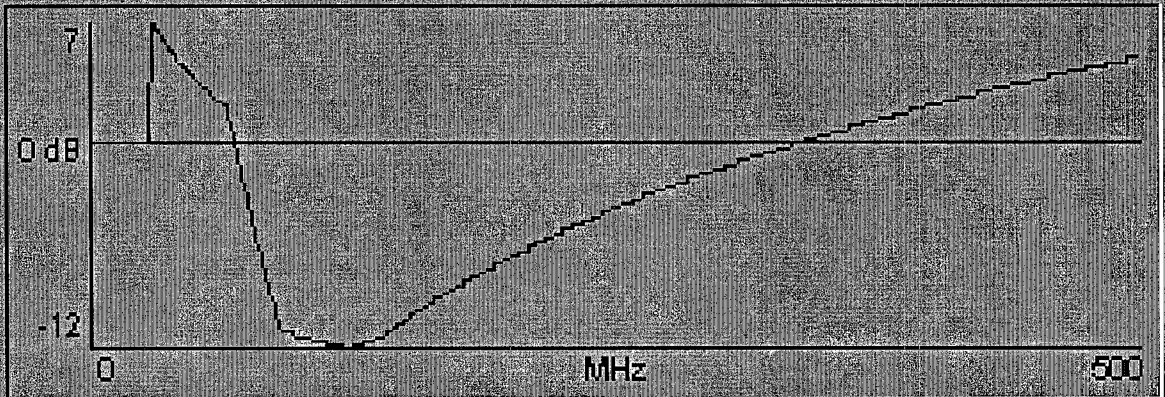
Display: dBuV / f
Traces: Current,Limit
Status: Saved

Input:	RF200
Length:	2 m
Port:	COM1:
A-P Distance:	3 m

Gain: 18 dB

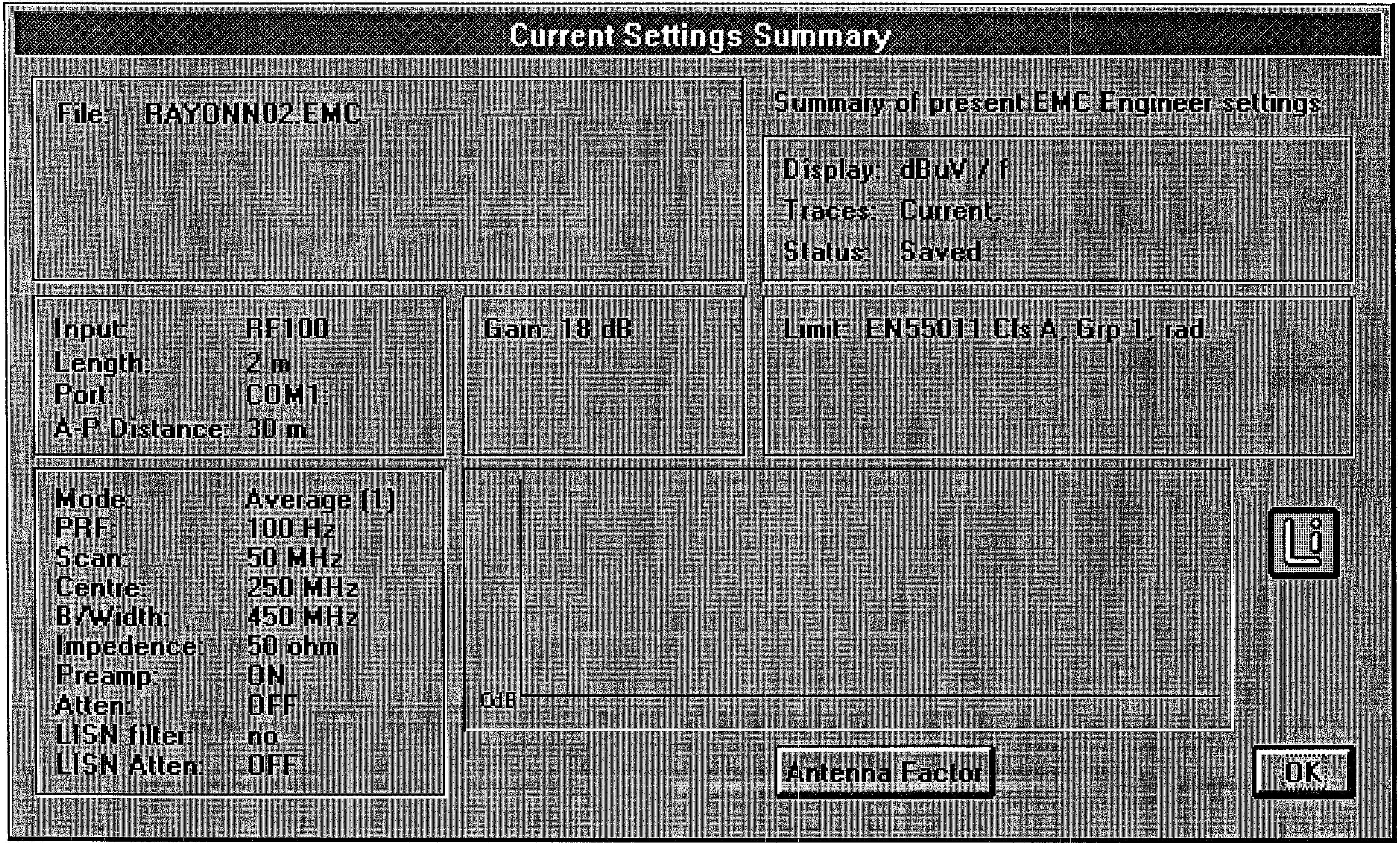
Limit: EN55011 Cls A, Grp 1, rad.

Mode:	Average (1)
PRF:	100 Hz
Scan:	50 MHz
Centre:	250 MHz
B/Width:	450 MHz
Impedence:	50 ohm
Preamp:	ON
Atten:	OFF
LISN filter:	no
LISN Atten:	OFF



Antenna Factor

OK


Current Settings Summary
File: RAYONN02.EMC
Summary of present EMC Engineer settings
Display: dBuV / f
Traces: Current,
Status: Saved
Input: RF100
Length: 2 m
Port: COM1:
A-P Distance: 30 m
Gain: 18 dB
Limit: EN55011 Cls A, Grp 1, rad.
Mode: Average (1)
PRF: 100 Hz
Scan: 50 MHz
Centre: 250 MHz
B/Width: 450 MHz
Impedence: 50 ohm
Preamp: ON
Atten: OFF
LISN filter: no
LISN Atten: OFF
0dB
Antenna Factor
OK

Current Settings Summary

File: CONDTE01.EMC

Summary of present EMC Engineer settings

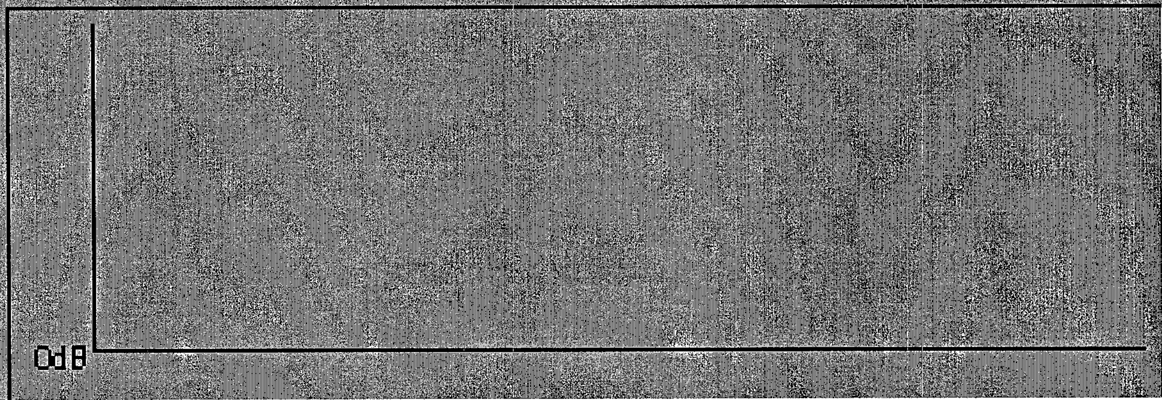
Display: dBuV / f
Traces: Current,Limit
Status: Saved

Input:	LISN (+ve)
Length:	2 m
Port:	COM2:
A-P Distance:	0 m

Gain: -22 dB

Limit: EN55011 Cls A, Grp 1, mains

Mode:	Average (1)
PRF:	100 Hz
Scan:	500 KHz
Centre:	2.5 MHz
B/Width:	4.5 MHz
Impedence:	50 ohm
Preamp:	ON
Atten:	ON
LISN filter:	no
LISN Atten:	20 dB



Antenna Factor

OK

Réglages du générateur de salves:

	Prog-A	Prog-B	Prog-C
V-nominal	0.500 kV	0.500 kV	0.500 kV
Polarity +/-	POS	NEG	POS
Trigger A/M	AUTO	AUTO	AUTO
burst ourput:			
• to HV-out	...	...	YES
• to line 1 phase	YES	YES	...
• to line 3 phase	...	...	...
1 ph coupling path:			
Path L	ON	ON	
Path N	ON	ON	
Path PE	ON	ON	
Path L+N	OFF	OFF	
Path L+PE	OFF	OFF	
Path N+PE	OFF	OFF	
Path L+N+PE	OFF	OFF	
Spike freq.	5.00 kHz	5.00 kHz	5.00 kHz
Burst dur.	15.0 ms	15.0 ms	15.0 ms
Burst freq.	3 Hz	3 Hz	3 Hz
Test time	60 s	60 s	60 s
Random spikes	OFF	OFF	OFF
Burst syncro	ON	ON	OFF
Syncro freq.	50 Hz	50 Hz	50 Hz
Syncro angle	90°	270°	90°
No transition	activ	activ	activ
Voltage trans	.....	.....	.....
Freq. trans	.....	.....	.....
Syncro trans	.....	.....	.....

Annexe D

Limites d'émission pour les equipements sous test

EN 55011

Fréquence centrale Mhz	Gamme de fréquences Mhz	Limite maximale de rayonnement
6,780	6,765 - 6,795	À l'étude
13,560	13,553 - 13,567	Sans restriction
27,120	26,957 - 27,283	Sans restriction
40,680	40,66 - 40,70	Sans restriction
433,920	433,05 - 434,79	À l'étude
2450	2400 - 2500	Sans restriction
5800	5725 - 5875	Sans restriction
24125	24000 - 24250	Sans restriction
61250	61000 - 61500	À l'étude
122500	122000 - 123000	À l'étude
245000	244000 - 246000	À l'étude

Tableau D.1: *Fréquences désignées par l'UIT comme fréquences fondamentales pour les appareils ISM.*

Limites pour les appareils de classe A dB(μV)				
Bande de fréquences MHz	Groupe 1		Groupe 2	
	En quasi-crête	En valeur moyenne	En quasi-crête	En valeur moyenne
0,15 - 0,50	79	66	100	90
0,50 - 5	73	60	86	76
5 - 30	73	60	90 Décroissant avec le logarithme de la fréquence jusqu'à 70	80 Décroissant avec le logarithme de la fréquence jusqu'à 60

Tableau D.2: *Limites des tensions perturbatrices aux bornes du réseau pour les appareils de classe A*

Limites pour les appareils de classe B dB(μV)		
Bande de fréquences MHz	Groupes 1 et 2	
	En quasi-crête	En valeur moyenne
0,15 - 0,50	66 Décroissant avec le logarithme de la fréquence jusqu'à 56	56 Décroissant avec le logarithme de la fréquence jusqu'à 46
0,50 - 5	56	46
5 - 30	60	50

Tableau D.3: *Limites des tensions perturbatrices aux bornes du réseau pour les appareils de classe B*

Bande de fréquences MHz	Mesuré sur un emplacement d'essai	
	Groupe 1 Classe A Distance de mesure 30 m dB(μV/m)	Groupe 1 Classe B Distance de mesure 10 m dB(μV/m)
0,15 - 0,50	A l'étude	A l'étude
0,50 - 5	30	30
5 - 30	37	37

Tableau D.4: *Limites du rayonnement électromagnétique perturbateur pour les appareils du Groupe 1*

Bande de fréquences MHz	Limites pour la Classe B Distance de mesure 10 m dB(μV/m)
0,15 - 30	Limites à l'étude
30 - 80,872	30
80,872 - 81,848	50
81,848 - 134,786	30
134,786 - 136,414	50
136,414 - 230	30
230 - 1000	37

Tableau D.5:*Limites du rayonnement électromagnétique perturbateur pour les appareils du Groupe 2, Classe B*

Bande de fréquences MHz	Limites pour la Classe A Distance de mesure 30 m dB(μV/m)
0,15 - 0,49	85
0,49 - 1,705	75
1,705 - 2,194	80
2,194 - 3,95	75
3,95 - 20	60
20 - 30	50
30 - 47	58
47 - 68	40
68 - 80,872	53
80,872 - 81,848	68
81,848 - 87	53
87 - 134,786	50
134,786 - 136,414	60
136,414 - 156	50
156 - 174	64
174 - 188,7	40
188,7 - 190,979	50
190,979 - 230	40
230 - 400	50
400 - 470	53
470 - 1000	50

Tableau D.6:*Limites du rayonnement électromagnétique perturbateur pour les appareils du Groupe 2, Classe A*

EN 55022

Gamme de fréquences Mhz	Limites dB(µV)	
	Quasi-crête	Valeur moyenne
0,15 à 0,50	79	66
0,5 à 30	73	60

Tableau D.7:*Limites des perturbations conduites aux bornes d'alimentation pour les ATI de Classe A*

Gamme de fréquences Mhz	Limites dB(µV)	
	Quasi-crête	Valeur moyenne
0,15 à 0,50	66 à 56	56 à 46
0,5 à 5	56	46
5 à 30	60	50

Tableau D.8:*Limites des perturbations conduites aux bornes d'alimentation pour les ATI de Classe B*

Gamme de fréquences Mhz	Limites quasi-crête dB (µV/m)
30 à 230	40
230 à 1000	47

Tableau D.9:*Limites des perturbations rayonnées à une distance d'essai de 10 m pour les ATI de Classe A*

Gamme de fréquences Mhz	Limites quasi-crête dB (µV/m)
30 à 230	30
230 à 1000	37

Tableau D.10:*Limites des perturbations rayonnées à une distance d'essai de 10 m pour les ATI de Classe B*

Annex B: The details of the test-equipment

The details of the test-equipment are given in Table B.1.

Name of apparatus	Type	Manufacturer
Burst Tester, EFT / Burst Generator	PEFT Junior	Haefely Trench A.G.
HF-Coupling Clamp	IP4A	Haefely Trench A.G.
Electro Discharge Tester	PESD 1600	Haefely Trench A.G.
Spectrum Analyser	SA450B	Laplace Instruments LTD
Computer Interface	SA1030	Laplace Instruments LTD
E & H near field probes	RF100	Laplace Instruments LTD
Log-Periodic Antenna	RF200	Laplace Instruments LTD
Pre-amplifier	SA1020	Laplace Instruments LTD
LISN	LISN1600	Thurlby Thandar Instruments Limited
Isolation Transformer	Type: Mono, N° 8498	BRC Transformateurs
Cage of Faraday	Amplisilence	Sispe

Table B.1.

All this equipment is bought by: DICOMTECH
Ringablach
56400 Plumergat
Tel: (33) 97 56 13 14
Fax: (33) 97 56 13 43

Literature

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